24. Sources and Pathways of Childhood Exposures to Pesticides

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Dr BALK: Our next speaker is Dr. Kirby C. Donnelly, who is a toxicologist. He's also professor and head of the Department of Environmental and Occupational Health at the School of Rural Public Health, Texas A&M University System Health Science Center in College Station, Texas. Dr Donnelly is going to speak to us about pesticides, which is a very big problem for our urban patients. In the Bronx where I practice, and in Manhattan where I grew up, we have a lot of roaches, and parents spray for roaches, exposing their kids to these chemicals.

DR. DONNELLY: Thank you very much. What I'll do first is give you my disclaimer, which is to let you know just how ignorant I am with respect to childhood exposure to pesticides. We have been conducting a study over the past three years, investigating levels of exposure, but I think a lot of what we've learned over the last three years is just how little we do know. What I will try to do in my presentation is to describe some of the overt clinical symptoms associated with some of the major pesticides in use and to discuss some of the methods for recognizing childhood exposure to pesticides. But more importantly, what I'll try and do is to describe some of the behavioral factors that can influence exposure. And then finally, based on some of the work that we've done, I'll discuss some of the methods that you can use to prevent childhood exposures to pesticides.

So the first question is: Are children small adults? The answer, of course, is no. Children are very willing to be exposed to soils and put soil in their mouths and they are willing to handle contaminated and dangerous materials. Not only are a child's behavioral activities very different from an adult, but also his metabolic capabilities and his immunological capabilities are very different. So children are not small adults, and towards the end of this presentation I'll show you a video clip about one of the children with whom we worked, and it will demonstrate how easy and likely it is for children to be exposed to pesticides.

We have evolved greatly in our ability to control insects. (Figure 24-1) At first we just bopped them or we stepped on them. There were some early pesticides, many of which were naturally derived.

Then in the early 1900s, we came up with organochlorines. These were followed by organophosphates (OP), then by the pyrethroids, and then some newer pesticides I'll talk about briefly.

The organochlorines included agents like DDT and Chlordane. (Figure 24-2) Most of these are now banned in the United States, but they're still in use in developing countries. Those of you who work in areas near the border, and I consider College Station to be near the border, so I certainly consider San Antonio to be near the border, know that people can go into Mexico and get some of these banned pesticides and bring them back for uses in the United States. These are very nonspecific pesticides, which means they work really well. In fact it means that they have saved, according to the World Health Organization, over 5 million lives because of their ability to control mosquitos and other vectors for disease. Categories of organochlorines include the dichlorodiphenyl ethanes, such as DDT; the cyclodienes, such as chlordane; and the chlorinated benzenes such as hexachlorobenzene and lindane. (Figure 24-3) These are used primarily to control houseflies and mosquitoes, but they have also been used on field crops and fruits and livestock. Aldrin is used for corn pests and timber preservation, as well as for termite-proofing. Termite-proofing, incidentally, is one situation where as physicians you may see patients who were exposed in their houses.

The acute effects of exposure to DDT include paresthesia of the tongue and lips, irritability, dizziness, and vertigo. With these acute exposures, it's likely to be fairly obvious, and in fact, the individual probably knows he or she was exposed. They either ingested these chemicals intentionally, or they may have been using them and accidentally been exposed to a high amount. Chronic exposure is different. We know the organochlorines are hepatotoxic. (Figures 24-4) Although there is no confirmed evidence of their carcinogenicity, there are two studies in the literature now that link increased levels of DDT in breast tissue to an increased risk of breast cancer. However, there are other studies that repute that. So whether or not DDT can cause breast cancer is uncertain, but there are some preliminary studies that suggest this linkage. Treatment of acute poisoning includes diazepam or phenobarbitol to control seizures. (Figure 24-5)

From the organochlorines we evolved to the organophosphates and the carbamates. These were developed from nerve gases, and so these are very toxic chemicals. (Figure 24-6 and 7) There are over 200 different organophosphates in use today and about 25 different carbamate insecticides. These are the primary insecticides that are used for agriculture in the state of Texas. Some of the examples of the organophosphates include diazinon, methyl parathion, parathion, and chlorpyrifos. The carbamates include aldicarb, carbofurans, and merthiocarb.

Clinical conditions. When I speak with the students, basically what I tell them is with organochlorine and organophosphate poisoning, the patient has fluid coming out of every pore in his body—salivation, lacrimation, urination, defecation. (Figure 24-8) There is also hypertension, tremors and weakness. There may be central nervous system effects, including restlessness, ataxia, lethargy, convulsions and coma. With parathion, fenthion and chlorpyrifos, there is also an organophosphate-induced delayed neuropathy. We are just now beginning to understand what target in the central nervous system these OPs have.

Most of the OPs target acetylcholinesterase (ACHE). But the OPs that can produce this delayed neuropathy seem to target a neurotoxic esterase, which is a little bit different and in which cases the effect may follow the exposure by more than 24 hours.

Patients with OP poisoning should be hospitalized. (Figures 24-9 and 10) You need to monitor their cholinesterase and erythrocyte ACHE levels. The inhibition of these three enzymes is a very good indication of the severity of the poisoning. These patients may require some immediate artificial respiration if the exposure was very high. There are case studies of agricultural workers using backpack sprayers, and the backpacks would leak and they'd get OPs on their clothing and skin and consequently very high levels of exposure from this. Atropine may be used to counteract the effects of the accumulating neurotransmitter. In some cases, you may need to cure the nicotinic and CNS signs and symptoms by administration of pralidoxime. (Figure 24-11)

The most recent pesticides to see widespread use in the United States are the pyrethroids. (Figure 24-12) The organic gardeners love these because these are organically occurring, or naturally occurring, chemicals. They entered the market-place in 1980. By 1982 they accounted for about 30 percent of the worldwide usage, and because they are derived from botanical insecticides, people consider them to be much safer. We do know that these chemicals had some agricultural use before widespread use as household sprays and flea preparations.

There are acute effects of exposure, although they are not considered to be highly toxic to mammals. (Figure 24-13) Skin exposure may lead to contact dermatitis. There may also be some asthma-like attacks due to ingestion. Chronic effects are very uncertain. There are some preliminary animal studies, within the last two years, that have reported cancer in animals that were exposed to pyrethroids.

Treatment. (Figure 24-14) Remove from the exposure. You may need to use Vitamin E cream to alleviate the dermal paresthesia, Other treatments would be symptom-related, such as inhaled steroids for asthma.

I said that there are new pesticides that have been developed. Figure 24-15 is a list of new insecticides. Surprisingly, despite the fact that these are primary neurotoxins, but there's no reported toxicity in humans. I don't know if that means that these are not toxic in humans or if it just means that they haven't been reported to be toxic in humans. The new botanical insecticides include nicotine and the rotenoids. (Figure 24-16)

The insecticide dust may be irritating to the eyes, the skin, and the upper respiratory tract.

What I'd like to do for the last portion of this presentation is to focus on sources of exposure to pesticides. This is something that I've been working on for the last three years in a colonia located near Laredo, Texas. Sources of exposure include ingestion of contaminated foods. (Figure 24-17) We do have pesticides in our fruits and in a variety of the foods that we eat, but the levels generally are quite low. I think the quality of food in this country is remarkably good. So generally, the level of exposure from ingestion of contaminated foods is going to be quite low. But then you also have the problem that children eat a lot of fruit. They eat a lot of bananas and a lot of apples. In fact, the ingestion of fruit per unit body weight is much higher for infants and children than for adults, and so they may be getting a higher level of exposure to pesticides.

Another source of exposure is drift from agricultural fields. The community that we're studying is located adjacent to an agricultural field, and our concern is that as pesticides are sprayed on this field and as the dust blows away from the field, are these chemicals entering the houses? This would create another source of childhood exposure to pesticides. There's also concern about contact with animals. If someone dips an animal in a flea dip to control fleas and then the animal comes in the house where the child plays with the animal, puts his hands on the animal, and then puts his hands in his mouth, what is the level of exposure?

There is concern not only about household or garden use, but more important about household or garden misuse. Are these chemicals being abused in the garden, being overdosed in the garden, or being used in the house when they should only be used outside in the garden. We really don't know. One of the families in our study would mix organophosphate insecticide with Vaseline and use this to comb through the children's hair to control head lice. Needless to say, this could be a major source of exposure, but it's something about which we really don't have very significant quantitative information.

The study that I would like to talk to you about was an investigation of pesticide exposure by children in an agricultural community on the U.S./Mexico border. The purpose of the study was to better understand children's behavior and how that behavior affects their exposure to pesticide. Also, we wanted to learn what level of pesticides were present in this rural community.

We detected both organochlorine and organophosphate insecticides in this community. We found that the level of organophosphates tended to be 100 to 1,000 times greater than the levels of organochlorine, so most of the study focused on organophosphates. We collected samples of house dust, hand rinse, and urine samples over a three-year period. We had five different monitoring points. In fact, we just completed another trip to Laredo to do more monitoring about a month ago. We collected over 500 samples from 34 families and 51 children within these houses. We not only collected hand rinse samples, but we also did a baseline hand rinse before we videotaped and then another one after the videotaping.

We monitored each chore for four hours, and it was funny to watch some of the promotoras literally chasing the kids to videotape them as they ran around the house, got on their bicycles, went outside, rode their bicycles, went back and forth, etc. We worked our promotoras quite hard.

These ladies did an outstanding job, both collecting samples and the videotaping. So we have videotapes to help us understand what behavioral activities could influence their exposure to pesticides. What we observed was that as the child gets older, food-handling activities were increased. This is what we expected.

As they get older, they can feed themselves more readily, and so their food to mouth or hand to food activities go up, but we also found that their hand-to-mouth and object-to-mouth activities go down as they get older. (Figure 24-18) When they're very young they're teething. They tend to put their hands in their mouth; they like to suck their thumbs. But as they get older, these activities go down, and so one would assume if they are being exposed to pesticides through putting their hand or putting objects in their mouth that we would see a decrease in pesticide levels as the children get older.

In the U.S., the 90th percentile for organophosphate level in the urine is less than 10 parts per billion. In Figure 24-19 you can see that a large portion of the children in our population have levels that are greater than 10 parts per billion. I can also tell you that for a pesticide applicator, the level in the urine is over 100 parts per billion. So I've got five children in this study who had pesticide levels that were greater than 100 parts per billion, or greater than you would see in a pesticide applicator.

We were concerned about one young girl whose levels were actually over 1,000 parts per billion. And so we went to the house. We worked with the sister who is the director of a hospital. We visited with the parents. We arranged for a pediatrician to handle follow-up on this one particular child. Her levels have been maintained over 100 parts per billion. In visiting with the child, I found that she couldn't speak very well. She's three years old. She couldn't complete a sentence, and she still wasn't potty-trained, even though a cousin who lived in her house with her, who was only 18 months old, could talk a blue streak and he was potty-trained.

So being a toxicologist, my initial assumption was that surely, this child is exhibiting a chronic effect of exposure to organophosphate insecticides. She's got them in her urine. She's showing these behavioral problems, so surely this must be the reason. But after visiting with the promotoras who were very good at obtaining medical histories from some of these children and from their parents, what we discovered was that Mom was an alcoholic. The child was living with her grandmother. We now think that it may be more likely that her behavioral activities and her learning disability, could be more related to fetal exposure to alcohol than to these pesticides.

Figure 24-20 shows how pesticide levels in the urine change by age. You can see that levels are very low below one year. Over the next 4 years they go way up and then they come down, and then they go up again. We have no idea what causes this.

We're thinking it may be because they go outside more, but we really don't know.

Now I have this only two-minute video. This is one of the little boys in our study, and he has an older sister and a twin brother. You see he's been given a chicken wing to eat, and he gets up and he moves around.

This is about 30 minutes of activity that was monitored and condensed into two minutes. He has the chicken wing in his mouth for few seconds. Then it's back in his hands, back to his mouth, and then he puts it on the couch. I think he's been on the floor at least once or twice.

Yes, it's a good chicken wing, too; you can tell. Now, what I really want you to watch—now, he's kind of dancing around here—in just a second, Mom's going to come into the screen. And keep a very careful eye on Mom's left hand and the chicken wing, which is right just behind his shoulder. Finally Mom comes, and she's really slick. She's going to slip around behind him, and snatches the chicken wing when he's not looking. Now, I don't know, but I'm assuming she threw it out the window, and the child probably went out the door about two minutes later and picked up the chicken wing again.

Okay. So we know that pesticide levels change in the home during the year. In this community that it may be related to the fact that they leave their windows and doors open more in the summer. We know that some pesticides stick to children's hands more than others. In fact, we found that in some cases, the pesticide levels on these kids' hands was higher than on the floor, because they've got oil and grease on their hand, and that helps to dissolve these pesticides. The pesticide levels on the children's hands were higher than we saw in the house dust.

So how can we decrease childhood exposure to pesticides? (Figure 24-21) Well, obviously, the first thing is never to use pesticides labeled for agricultural use in the homes. We know that it happens, but it is dangerous. Try harder to wash children's hands before they eat. Thinking back to when my children were two and three years old, I know how hard it was to wash their hands or get them to wash their hands.

We had a community meeting about two months ago or two weeks ago and tried to relay this information to community, at which point someone asked, "Do you know how hard it is to wash kids' hands and keep them clean like that?"

Wet-mop floors where children play to keep down dust. (Figure 24-22) And finally, if you're talking to your patients, tell them to use caution when using pesticides, whether in the house or on pets or in the garden. Make sure you read the labels. Make sure you use them properly. If it says a tablespoon per gallon, don't use four tablespoons.

I want to acknowledge the fact that we had a lot of help with this study. I'm funded by the NIEHS on a superfund basic research program. This particular study was funded by the U.S. EPA on a childhood exposure to pesticides grant. We've had a tremendous amount of help from the South Texas Environmental Education and Research Group.

In Laredo specifically, help from Joan Englehart, Roger Perales, and this study would not be possible without the help of the promotoras of the Sisters of Mercy, specifically, Sandra Contreras, Millie Thomas, and Carmen Rodriguez. And last but not least, the big bucks—this also was supported by the NIEHS Center for Health Sciences and a NIEHS Center for Environmental and Rural Health.

DR. BALK: We have a few minutes for questions. For Vincent Torres, we have quite a few mold questions. The first question is "Any thoughts about stachybotrys and pulmonary hemosiderosis? Is the association real?"

MR. TORRES: I'll leave that to the experts who are continuing to study that. I think there is information that shows a concern, but they are continuing to collect evidence on additional cases and I think it would be premature to say that yes. I think this illustrates that collecting information after the fact is very, very difficult and needs to be very closely controlled.

DR. BALK: Let me just give some background for people who might not know about the association found between infantile pulmonary hemorrhage and living in a moldy environment. There was a cluster in Cleveland in the early '90s, and what the Academy of Pediatrics is suggesting that infants not be exposed to mold in the environments until more data come in, which makes total sense to me.

DR. MILLER: There have been some reports which questioned this relationship. It's important for us to remember in public health that we don't have to know everything before we do something. The maneuver of removing people from exposures or the exposures from the people and seeing what happens is extremely important. You could go on forever looking at these kids up in Cleveland, because there were multiple molds and tobacco smoke, and you can have allergists arguing until the cows come home. There's diasporin and penicillium, and how do you know it was really just that mold, and so on. You have to be practical, and I think this is where industrial hygienists and field people who are out there on the front lines have some very good sense. The engineers are sometimes more sensible about these things than some of the academics.

DR. BALK: Here's another question on mold. If mold is visible in a home or a school, do you recommend testing to determine the species or level of mold spores; or should a person simply repair the water leak and clean up the mold, regardless of the species or levels?

MR. TORRES: I'm going to give the old "It depends." In some situations documentation of the type of mold present may be necessary for some particular reason, but not always. You said the mold was visible, so doing some tape sampling is relatively inexpensive. If no one is having symptoms possibly attributable to the mold contamination, then knowing or not knowing what the mold is not critical and I don't particularly advocate sampling. Where I think a lot of people fail, and I don't mean to criticize industrial hygienists, but we put some people in the position of diagnosing the problem but they are not experts at building science and forensics. It is imperative to identify the water source.

As long as you solve the water source problem accurately, you can go in, remove the mold, fix the water source problem, and make sure that you have all the water source problems fixed, and then you will be okay. I can't overemphasize how critical it is to be sure that you've truly diagnosed the source of the water problem.

DR. BALK: One more question. What is the local agency in San Antonio that can answer and investigate mold problem inquiries, other than the San Antonio Health Department?

DR. GUERRA: We, that is the Health Department, can go out and do an environmental assessment and collect specimens, but we use outside laboratories to process them for us and outside environmental-consulting groups to do the more extensive investigating. We don't have the resources to do it ourselves. I'll say more about that in my presentation, but public health could really serve as a broker and facilitate trying to connect the broader community to the resources for that.

MR. TORRES: Let me add one other thing. We view diagnosing a mold problem as a team effort. You can't expect one individual to understand everything about mycology, building science, health effects, design of a home or building, how that home should operate, if it has an HVAC problem, etc. So when you're dealing with something other than a very simple mold problem, you really need a team that represents multiple disciplines. Many times there are multiple things wrong with a building. In the case of Hill Elementary, which I spoke about, we had water coming up through the floor, we had roof leaks, and we had an HVAC system that was not operating properly because the outside air vent had been closed.

DR. BALK: I was wondering in your presentation, thinking about the team approach, were there pediatricians involved?

MR. TORRES: No, and it was amazing. The only way I was able to get some pediatricians and some health professionals involved was through my personal knowledge of certain people to whom I could refer parents. I said "Look, you need to call this person, because I know they know something about this issue." It so happened that the father of one of the children was on loan from CDC, and so I was able to pull some strings to get them to do an after-the-fact, epidemiological study, basically, a questionnaire follow up to what had happened.

I even got calls in the evening from pediatricians and nurses and other health professionals, asking me what I could share with them about mold and what they should be looking for in the children.

DR. MILLER: I think this goes back to the lack of health professionals who are schooled in this area. They don't exist in medical schools. There are few champions, if you will, for environmental health. If you don't learn about it, it's not important, and then when you're faced with a problem, you don't know where to turn and you don't know what the resources are.

And without the physician seeing something, oftentimes a school won't be willing to intervene. In fact, the usual thing that happens is the parents get up in arms and then the school board's jobs are on the line, and then that's when the dynamics shift, when they think they won't get reelected.

MR. TORRES: Let me just add one more thing. With regard to allergies. Once again, I'm not a medical professional, but my son was affected by the situation, and his teacher was one of the teachers that had to be taken to the emergency room twice. I could see that something was wrong, something was changing. He was changing from being a very healthy person, not ever being stuffy, not having cough, all of a sudden to being ill and not able to get well. He was very congested. It developed into a cough. We took him to the doctor repeated times, because he just wasn't feeling well. We wanted to have him tested for allergies because we thought he was becoming sensitive to some allergens. But the doctor really didn't want to recommend him, and without a referral, we couldn't get that done. And his explanation to us was "You really can't tell anything at this point. We'll just have to let him work it through." I think that was a very typical response that a lot of parents were receiving.

DR. BALK: We are going to move to pesticide questions for Dr. Donnelly. "Regarding pesticides on fruits and vegetables, is washing effective? Do the pesticides penetrate the peels?"

DR. DONNELLY: Washing is effective, and will remove at least 50, probably 70-80 percent of the pesticides. With something like a carrot or a potato where you can peel the outer layer, that will take off 95 to 99 percent.

DR. GOLDMAN: Can I just ask you another question, because some of the pesticides are systemic and go into the fruits as opposed to being in or on the peel, so you can't do much about that?

DR. DONNELLY: Agreed, you can't do much about that.