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Integrating Environmental Health Into Nurse Practitioner Training—*Childhood Pesticide Exposure Risk Assessment, Prevention, and Management*

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Abstract

The use of pesticides in agriculture, public places, and private homes and gardens is ubiquitous throughout the United States. Children are particularly vulnerable to pesticide exposure because of immature biological and developmental processes. Thus, it is important that primary health care providers identify clients at risk for pesticide exposure and poisoning and know how to respond effectively if clients experience exposure. However, many primary health care providers are not adequately trained or prepared to manage the health-related effects of pesticide exposure. Recent efforts, supported by the U.S. Environmental Protection Agency, have addressed this shortcoming in nursing and medical education. A primary initiative is to find ways to integrate basic environmental health content, specifically regarding pesticide exposure, into nursing and medical curricula. As one strategy to achieve this, a pilot case study was developed by revising and enhancing an existing pediatric case study used in a required course for nurse practitioner students. The aim was to raise students' awareness of risk assessment, prevention, and appropriate care strategies for pesticide exposure. Evaluation of students' experience with the pilot case study suggested it was a meaningful and valued addition to their training, as well as an efficient way to introduce environmental health content into primary health care provider curricula.

More than an estimated billion pounds of active pesticide ingredients are used annually in the United States, representing approximately one quarter of worldwide pesticide use (Kiely, Donaldson, & Grube, 2004). The U.S. Environmental Protection Agency (EPA, 2008) defines pesticides as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, including herbicides, insecticides, fungicides, and rodenticides. Pesticides are used to manage and eradicate unwanted pests (e.g., weeds, insects, rodents, fungi, microorganisms) that negatively affect living conditions or spread disease (EPA, 2007). They have also been credited with revolutionizing the global food supply by significantly increasing fruit and vegetable yields and enabling agricultural production in inhospitable growing areas (Zilberman & Sexton, 2008). In addition to agricultural uses, pesticides are present in products used to control insect or rodent infestation in homes and gardens or to disinfect household surfaces. Some estimates suggest that the amount of pesticide used per acre on home lawns and gardens often exceeds that used in agriculture (Kiely et al., 2004).

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Because pesticides are designed to impair essential biological processes, which are often similar among very different organisms, exploring the serious, and even unintended, health hazards of pesticide use for humans has become increasingly important. In the 1960s and 1970s, scientific studies began to examine whether links existed between pesticide use and human health. Heightened attention and a growing body of research have resulted in the availability of data demonstrating the acute toxic effects of many commonly used pesticides. However, implications related to chronic pesticide exposure remain somewhat arguable (Sanborn et al., 2004) and require further investigation.

Given the variety of classes, sources (e.g., food, water, environmental, residential, occupational), and routes (e.g., oral, inhalation, dermal) of pesticide exposure, determining health risks associated with chronic exposure can be complex. Accurate estimation of risk requires counting overall, aggregate exposure (Boobis et al., 2008). Cumulative risk is particularly important for pesticides that share a common mechanism of toxicity, such as organophosphates and carbamates, which can have serious additive effects (Reigart & Roberts, 1999). Additionally, assessments of pesticide exposure risk must consider differences in the impact of exposure on vulnerable populations, particularly infants, children, pregnant women, and women of child-bearing age (Castorina et al., 2003). Estimating the long-term risk of pesticide exposure, while considering variations in body weight, sex, and demographic characteristics and changes in food consumption patterns, poses a difficult challenge. Nonetheless, research does show that chronic exposure to pesticides can produce a wide array of negative health effects, including neurologic toxicity, neurodevelopmental impairment, cancer, and dysfunction of the immune, reproductive, and endocrine systems (Goldmann, 2004; National Research Council, 1993; Sanborn et al., 2004).

PESTICIDE EXPOSURES AMONG CHILDREN

The growing awareness of environmental health hazards has led to increased attention to the health impact of pesticide exposures among children (McCurdy et al., 2004; Sanborn et al., 2004). The Centers for Disease Control and Prevention (CDC, 2005) reported that children have twice the amount of pesticide by-products in their urine compared to adults. Pesticide exposure is prevalent among children living in both rural/agricultural and urban/suburban communities (National Environmental Education and Training Foundation [NEETF], 2003a). For example, a study conducted in the Seattle metropolitan area found that approximately 90% of toddlers studied had at least one organophosphate pesticide metabolite detectable in their urine (Fenske, 2002). Furthermore, research comparing children in Washington State showed that urban children had higher levels of urinary organophosphate metabolites compared to rural children (Fenske, Lu, Curl, Shirai, & Kissell, 2005).

Children are especially at risk for pesticide exposure and related health effects because of behavioral and developmental characteristics, including hand-to-mouth behaviors and being close to the ground. Pesticides are often used in homes and in public and personal gardens where children might play. Children may also have direct contact secondary to unintended incidents, such as pesticide spills or ingestion of household pesticide products. Infants and children may also come into contact with persistent and bio-accumulative pesticides through breastfeeding (Goldmann, 2004). Pets can also be a source of pesticide exposure for children through the use of anti-flea and tick products. A recent report suggested that residue levels produced by some flea collars are high enough to “pose a risk of cancer and damage to the neurological system of children up to 1,000 times higher than the EPA’s acceptable levels” (Rotkin-Ellman & Solomon, 2009, p. 4).

Para-occupational (or secondary take-home) exposures can occur when family members working with pesticides (e.g., in agriculture) track them into vehicles and homes via clothing. A study on organophosphate pesticide exposure among children in an agricultural community in Washington State showed that pesticide residue concentrations were seven times higher in the homes of children of agricultural workers than non-agricultural workers, and that pesticide residue concentrations in the urine of those children were five times greater than those of children of non-agricultural workers (Lu, Fenske, Simcox, & Kalman, 2000). Additionally, children may be assigned chores in agricultural work settings because parents may bring them to work due to a lack of child-care options.

Children can also ingest higher doses of pesticides than adults, making them more vulnerable. Children typically eat and drink more per kilogram of body weight than adults, and have more skin surface per kilogram of body weight. Babies up to 1 year of age have more permeable skin than adults. Also, children inhale more per day than adults and have incomplete development of liver and kidney detoxification mechanisms (EPA, 1997; Selevan, Kimmel, & Mendola, 2000).

KNOWLEDGE AND TRAINING ABOUT PESTICIDE EXPOSURE AMONG PRIMARY HEALTH CARE PROVIDERS

Primary health care providers can play a central role in raising awareness among families about the dangers of pesticide exposure. Nurse practitioners and other advanced practice nurses are particularly well suited to provide such information because of their direct interaction with clients and responsibility for health education (NEETF, 2003a; Salazar, 2000). However, despite growing public concern about pesticide exposures, primary health care providers often do not offer adequate pesticide information (Temte & McCall, 2001).

To prevent and diagnose pediatric pesticide exposure and poisoning, health care providers must acquire and maintain fundamental knowledge about environmental risk assessment as well as clinical management of such cases. It can be difficult to recognize pesticide-related illnesses because symptoms of poisoning (e.g., nausea, vomiting, dizziness, headaches, skin rashes, and eye irritation) often resemble other health problems, especially among children. However, education of primary health care providers about general environmental health issues and, more specifically, pesticide exposure is limited (Balbus, Harvey, & McCurdy, 2006; McCurdy et al., 2004). Studies of physicians reveal that many do not feel their medical training adequately prepared them to address environmental health concerns (Balbus et al., 2006; Hu, Adams, Boscarino, & Laraque, 2006; Karr, Murphy, Glew, Keifer, & Fenske, 2006). Another study of pediatricians illustrated that although 50% of them had encountered patients who had been seriously affected by an environmentally related exposure, only 20% reported having had any training in environmental health history taking (Kilpatrick et al., 2002). Among most primary health care providers, knowledge specific to pesticide exposure and poisoning is similarly nonexistent or severely limited (Balbus et al., 2006; Karr et al., 2006; NEETF, 2003a).

Nursing education also has experienced a shift in emphasis away from environmental health issues (Butterfield, 2000). Reasons noted for this include the lack of faculty prepared to teach environmental health content and limited curricular time and resources that make it difficult to incorporate environmental health material into already full programs of study (Hewitt, Candek, & Engel, 2006; McCurdy et al., 2004). Despite this, integration of environmental health issues into general, as well as pediatric-specific, nursing and medical programs is becoming more of a priority, prompting a search for innovative ways to incorporate this content into curricula (Hewitt et al., 2006; McCurdy et al., 2004; NEETF, 2003a).

The National Strategies for Health Care Providers: Pesticides Initiative, a program of the NEETF, in partnership with the EPA and the U.S. Department of Health and Human Services, U.S. Department of Agriculture, and U.S. Department of Labor, targets nursing and medical education programs to improve the training and ability of health care providers to recognize, manage, and prevent pesticide-related health risks (NEETF, 2003b). A primary strategy incorporates content reflecting core competencies for nursing and medical education into existing curriculum. These core competencies are (1) knowledge and concepts of pesticides, including individual and community risk assessment; (2) diagnosis and assessment, including environmental history taking, differential diagnosis, and common signs and symptoms; (3) treatment, intervention, and referrals; (4) risk communication, including education and anticipatory guidance; and (5) reporting requirements and regulations.

PROJECT DESCRIPTION

To address the critical need to educate primary health care providers about environmental health risks, a pilot effort was undertaken at the University of Washington to integrate basic pesticide information, with a focus on pediatric exposures, into an existing curriculum for nurse practitioners. The aim of this specific project was to raise awareness about pesticide exposure and to assess appropriate strategies of care among graduate nurse practitioner students. To achieve this, a pilot case study focused on pesticide training content was developed by revising and enhancing an existing case study used in the curriculum for a health promotion course. The course is required for graduate nurse practitioner students in the following specialty areas: pediatric, family, adult/older adult, acute care, and rural nurse practitioner. It was selected as an insertion point for pesticide training content because it emphasizes health promotion, risk reduction, screening, and disease prevention in primary care.

Through online, web-based case studies, students addressed health care issues for various population groups, including infants, pregnant women, toddlers, adolescents, and the elderly. Case studies were designed to facilitate students' understanding of various health risks and necessary screening and education specific to certain patient populations. Case studies were originally created by the course instructor and are representative of actual cases seen in primary care. A supplemental pesticide component was developed for an existing case study. The goal of this supplemental piece was to introduce students to pediatric pesticide exposure and provide them with resources that would enable them to find further information should they seek it, rather than provide a detailed curriculum or comprehensive training on pesticides and treatment.

Case Study Content

The case study scenario involved a fictitious 3-year-old toddler (client), the son of an agricultural worker in rural Yakima, Washington. Students were provided background health and social information about the client, who presents for a routine well-child visit. The Sidebar contains the case study that was presented to students.

Because the course focuses on health promotion and disease prevention, students are first asked to identify the health risks encountered by this child. Associated course readings and lecture are designed to encourage students to think about the following primary health risks for most young children: accidents (non-motor vehicle related and motor vehicle related), poisoning, and lack of immunizations. To introduce the topic of pesticides, an additional risk factor was added within the poisoning category specifying pesticide poisoning. Students selecting this risk factor were directed to supplemental material on pesticides: pesticide overview, routes and patterns of exposure for higher-dose pesticide exposure, attributes of

the case that make pesticide exposure a relevant risk factor, basic management of acute pesticide poisoning, chronic pesticide exposure, role of the nurse practitioner in prevention and screening, importance of taking an environmental exposure history for timely diagnosis, anticipatory guidance that enables parents or guardians to limit childhood pesticide exposure, and a resource list with additional Internet links (e.g., EPA, Pediatric Environmental Health Specialty Units, National Pesticide Information Center, National Library of Medicine Household Products Database).

Case Study

You are a nurse practitioner in a community clinic in Yakima, Washington, seeing this client, Paul, for the first time. Paul, a 3-year-old White/Hispanic boy, is accompanied by his mother and 12-month-old sister. His mother states she brought him in because, "I think he's behind on his shots," and she desires a well-child examination. Paul lives with his parents, sister, and paternal aunt. His father is an agricultural worker. His mother does not work. Paul was last seen 2 months ago in the emergency department for stitches when he cut his forehead during a fall from a porch. He has had prior well-child visits.

Evaluation

A modest evaluation of this pilot supplemental pesticide training component was conducted immediately after implementation in the course in fall 2008. To assess student satisfaction, students were asked to respond to an anonymous 6-item questionnaire via an online survey tool at the end of the case study. The questionnaire sought to determine students' opinions about usefulness, time to complete, and helpfulness of links. Students were also given the opportunity to provide short explanations to clarify their responses.

Although students from several practice areas were enrolled in the course, only family nurse practitioner (FNP) and pediatric nurse practitioner (PNP) students were required to complete the case study because it involved a toddler. However, students in other nurse practitioner specialty areas were welcomed to view the pesticide component. A total of 17 (8 FNP and 9 PNP) students were enrolled in the class who could have reviewed the pesticide component. Although the module and evaluation were voluntary, the course instructor encouraged students to complete them. Twelve (71%) of the 17 students who were required to read the toddler case study evaluated the pesticide component. All responded that the information was somewhat or extremely useful, with the majority (75%) finding it extremely useful. Two respondents noted that the information was not new to them. Another three indicated they wanted more information, specifically regarding how often the diagnosis of pesticide poisoning is missed, common pesticides that might be in most homes, and foods to avoid even if choosing among organic items. Half of the respondents stated that they accessed other resources linked to the case study, including "Recognition and Management of Pesticide Poisonings" (EPA, 1999), the Poison Control Center, the National Library of Medicine Household Products Database, Pediatric Environmental Health Specialty Units, and the National Pesticide Information Center. Reasons cited for not accessing additional resources included lack of time or having too much other school work, although students indicated they intended to keep the information for future reference.

The time needed to complete the supplemental pesticide component ranged from 8 to 60 minutes (average = 24 minutes). Those students who stated it took more time to complete the module were also those who stated that they visited some of the resource websites. All respondents found the format used to present the pesticide information agreeable.

DISCUSSION

Because of the potential adverse immunological, carcinogenic, neurotoxic, and reproductive health consequences, content on the health effects of pesticides is needed in the education of primary health care providers. Children comprise a vulnerable population disproportionately affected by pesticide exposure. Health care clients rely on primary health care providers to offer health promotion and risk prevention information. However, surveys of primary health care providers indicate that they lack formal training and knowledge to appropriately address pesticide-related concerns (Balbus et al., 2006; Karr et al., 2006). Surveys also suggest that primary health care providers would value having more information about how to address client concerns regarding pesticide exposure. In one study, 92% of pediatric health care providers, including physicians and nurse practitioners, stated that more pesticide information would be helpful in their work, particularly for the purpose of providing anticipatory guidance and prevention messages (Karr et al., 2006). Further, practitioners who had been educated about pesticide issues reported that they used this information in professional practice (Karr et al., 2006).

Although nursing education programs may claim that curricula are filled to capacity, a critical need remains to provide environmental health content, such as that related to pesticide exposure. The pilot project described illustrates an efficient way to integrate pesticide-related health information into existing curricula for nurse practitioner students. This endeavor serves as a first step toward meeting some of the NEETF pesticide core competencies for nursing education while imposing minimum burden on course instructors and avoiding dramatic increases in student workload. The instructor of the course in which this pesticide content was piloted noted that students who read the pesticide component identified pesticide exposure as a principal health risk factor during class discussions. These class discussions may foster pesticide awareness and encourage curiosity among fellow students who did not read the pesticide component. The piloted pesticide component will be fully integrated into the course for all students, making for a sustainable effort with the goal of reaching more nurse practitioner students each year. Future plans include developing additional, expanded pesticide-oriented case studies using the toddler's family members. Although providing more formalized and structured environmental health content for nursing education is recommended in the long term, this project illustrates a low-resource, concise method of raising awareness about pesticide-related health risks among nurse practitioner students. Evaluation results suggest that nurse practitioner students were interested in the topic and would use the provided resource materials in future professional practice.

LIMITATIONS

Evaluation of the project was limited by the small number of students who read the pesticide component of the case study, as well as the brevity of the questionnaire. Understanding more about students' receptiveness to the content, as well as gaining more specific information about their knowledge of and experience with pesticides, might have been useful in implementing changes in the present curriculum, or for developing similar curricula in the future. Surveying students' opinions about using an Internet-based case study to deliver the content would also have been informative. Also, because students were strongly encouraged by the instructor to view the pesticide content and complete the evaluation, it is unclear how many of them would have been motivated to view the content on their own. Thus, a more comprehensive and long-term evaluation of the case study approach is recommended.

Because the case study chosen as the insertion point for the pesticide content involved a toddler, the information was presented only to students who were studying to care for pediatric patients (e.g., FNP and PNP students). Because the class is also taken by students with scopes of practice that include only adults, had the additional pesticide components been designed for case studies more relevant for these specialties, more types of nurse practitioner students would have been reached. Finally, because the case study involved the child of an agricultural worker, it may contribute to the bias that children in rural settings are at increased risk of pesticide exposure, despite evidence to the contrary. Scenarios in an urban context would be helpful to effectively present a more balanced perspective about pesticide exposure among pediatric clients.

IMPLICATIONS FOR OCCUPATIONAL AND ENVIRONMENTAL HEALTH NURSES

This pilot project illustrates how occupational and environmental health nurses practicing as faculty and educators in nursing training programs can collaborate with faculty colleagues responsible for other specialty nursing academic programs (e.g., nurse practitioner programs) to expand their reach in teaching environmental health content. This project successfully merged two distinct streams of educational content (specifically pesticide exposure and health promotion for nurse practitioners) without competition for valuable class time or infringement on overall course objectives. This was achieved by carefully considering where environmental health content could be seamlessly, yet purposefully, integrated into course content while staying true to the goals of both the course and the EPA-funded parent project driving this effort.

Occupational and environmental health nurses not in academic settings (e.g., those in company, industrial, or even policy settings) can also serve as resource experts to local and regional nursing schools and colleges. They can partner with nurse educators to find innovative ways to broaden nursing curricula as well as raise interest in environmental health issues among nursing students. Given that the EPA is interested in finding ways to better prepare health care providers and personnel about environmental health issues, this is a call for occupational and environmental health nurses to share their expertise throughout their communities.

Also, targeting nurse practitioner students to receive environmental health knowledge, such as pesticide exposures, can encourage and socialize them to be environmental health advocates after they graduate. Increasing awareness and appreciation of environmental health issues among primary health care providers (nurse practitioners and physicians alike) can augment the fundamental clinical skills for which they are educated. Thus, they can be better equipped to serve their clients in professional practice settings, particularly those serving populations at risk for pesticide exposure and poisoning.

CONCLUSION

Pesticide exposure can be difficult to assess and manage, particularly among children. Because data on the chronic health effects of pesticide exposure are relatively limited, evaluating the long-term health consequences for pediatric clients compared to other health risks can be challenging. An array of pesticides are easily available to consumers, making their use increasingly prevalent. Further, newer pesticides with even higher toxicity are being developed and produced. Despite the critical need, many primary health care providers are insufficiently trained to handle at-risk clients, such as children. Efforts to increase the capabilities of nurse practitioners and physicians to identify and ameliorate potential pesticide exposure and poisoning are becoming essential. However, adding

environmental health content, such as that related to pesticide exposure, to packed, demanding nursing and medical education curricula can pose a challenge. One promising approach is to integrate environmental health content into required courses in nurse practitioner programs. Because nurse practitioners are on the front lines of primary health care delivery, preparing them with some level of environmental health content serves as one step toward ensuring they provide quality care, especially for children at risk for exposure to environmental pollutants.

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IN SUMMARY

1. Occupational and environmental health nurse educators can collaborate with faculty colleagues of other specialty nursing academic programs to expand their reach in teaching environmental health content.
2. Nurses with environmental health expertise can share that expertise with local and regional nursing schools and colleges to build environmental health capacity among primary care nurse practitioner students.
3. Including environmental health content in other specialty nursing training programs can encourage and socialize nursing students to be environmental health advocates in professional practice.