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Pesticides and PCBs:

Does the evidence show that they threaten children's health?

By Philip J. Landrigan, MD, MSc

Concern about children's exposures to pesticides, polychlorinated biphenyls (PCBs), and other environmental toxins has increased in recent years.[1] With growing frequency, parents are asking pediatricians whether chemicals in the environment pose a danger to their children now or in the future and whether even low levels of exposure can be harmful. They want to know if chemicals can damage their child's immune system, nervous system, or reproductive organs. And they ask about cancer. Couples who are expecting a baby are concerned, too, wondering about the risks of prenatal, and even preconception, exposure.

Such concerns are hardly surprising. The newspapers are full of stories about pesticide spraying, hazardous waste dumps, contaminated ground water, and polluted air. Parents are besieged by a welter of information about the potential health risks of chemicals to children. Pediatricians have, for the most part, been unprepared to address these issues, because the topics are so new and little attention has traditionally been focused on environmental health in medical school curricula or post-graduate programs.[2]

Children are, in fact, vulnerable to environmental toxins. In this article, I will try to unravel some of the complexities that surround the health effects of two major classes of environmental chemicals: pesticides and PCBs. *[Editor's Note: This excerpt does not include Dr. Landrigan's discussion of PCB exposure. If you are interested in the information on PCB exposure, please refer to the full article in the February, 2001 issue of Compemporary Pediatrics which can be found on their website http://cp.pdr.net or contact MCN and we can send you a full copy].* I refer readers who would like more detailed information to the *Handbook of Pediatric Environmental Health*, released in November 1999 by the American Academy of Pediatrics (AAP).[3] This land-

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To the members of the Migrant Clinicians Network

Health care providers rarely have time to consider matters of public policy. We focus on individuals; providing the best care to our patients is our priority and we are used to keeping our heads low in a demanding environment. It is time to scan the horizon. The current debate over the structure of a guest worker program has such a great impact on our work as clinicians and on the lives of farmworkers that we must raise our voice.

At the spring meeting in Puerto Rico the Board of Directors unanimously passed the following position statement:

> *The Migrant Clinicians Network is committed to ensuring access to health care for all farmworkers. Guest workers, foreign farmworkers with a temporary visa to work in the United States, are particularly vulnerable because they are dependent upon their employers for housing, transportation, and knowledge of local health services. Guest workers must be guaranteed transportation to medical care when requested and assured access to health providers at clinics and during outreach screenings and health education efforts.*

While not endorsing or rejecting any particular legislation, the statement does provide a set of principles and one key value: that the health of farmworkers cannot be compromised. Not by the need for labor, not by the desire for a functioning immigration system, not by the politics of the moment. We must insist that health care be a part of this debate, and that access to health care be guaranteed.

Colin Austin
Chairman – MCN Board of Directors

[Editor's Note: Please see the October, 2001 issue of Streamline for more information about the Guestworker issue. If you do not have a copy of this issue, you can download it from our website www.migrantclinician.org]

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mark guide, intended by the academy to be a counterpart to its handbook on infectious diseases ("The Red Book"), is an authoritative source of information. Like the Red Book, the "Green Book" will be updated periodically.

What makes kids so vulnerable to toxins?

Several factors explain why children are particularly vulnerable to pesticides, PCBs, and other environmental toxins (Table 1).[4] First, children have proportionately heavier exposures than adults to any toxins present in water, food, or air. That's because, pound for pound of body weight, kids drink more water, eat more food, and breathe more air. For example, children ages 1 through 5 years eat three to four times more food per pound than the average adult American. The air intake of a resting infant is twice that of an adult per pound of body weight. These patterns of increased consumption reflect the rapid metabolism of children.

Two other characteristics further magnify children's exposures to environmental toxins: (1) their hand-to-mouth behavior, which increases their ingestion of any toxic chemicals in dust or soil, and (2) their likelihood of playing close to the ground, which increases their exposure to toxins in dust, soil, and carpets, as well as to toxins that form low-lying layers in the air, such as certain pesticides.

In addition to being more heavily exposed to chemicals than adults, infants and children are biologically more vulnerable, for three reasons.[4] First, their metabolic pathways are immature, so their ability to detoxify and excrete certain toxins is different than that of adults. In some instances, children's bodies are actually better able to deal with environmental chemicals because they are unable to transfer them to toxic metabolites. More commonly, however, children's bodies are less able to handle toxic chemicals, and thus are more vulnerable to their effects.

Second, children mature rapidly, and their developmental processes are easily disrupted. Many organ systems in young children — the nervous system, the reproductive organs, the immune system — grow very quickly in the first months and years of life. During this period, structures are developed and vital connections are established. Indeed, the nervous system continues to develop all through childhood, as evidenced by the fact that children continue to acquire new skills as they get older — crawling, walking, talking, reading, writing. The nervous system has difficulty repairing any structural damage caused by environmental toxins. Thus, if cells in the developing brain are destroyed by chemicals, or if the formation of vital connections between nerve cells is blocked, there is a high risk that the resulting neurobehavioral dysfunction will be permanent and irreversible. The consequences can be lifelong loss of intelligence and alteration of normal behavior.[5]

Third, because children have more future years of life than adults, they have more time to develop chronic diseases that may be triggered by early environmental exposures. Many such diseases require decades to develop. Examples include mesothelioma caused by exposure to asbestos, leukemia caused by benzene, breast cancer that may be caused by dichlorodiphenyltrichloroethane (DDT),[6] and possibly some chronic neurologic diseases, such as Parkinson's disease, that may be caused by exposure to neurotoxins.[7] Many of these diseases are now thought to be the result of multistage processes within the body's cells that continue for many years before manifesting as illness. Consequently, certain carcinogenic and toxic exposures sustained early in life appear more likely to lead to disease than the same exposures encountered later in life.[4]

TABLE 1
Factors that put children at increased risk for toxicity

PHYSIOLOGIC

- Rapid metabolism leads to increased consumption, which leads to disproportionately heavier exposures to toxins in water, food, and air

BEHAVIORAL

- Hand-to-mouth behavior increases ingestion of toxic chemicals in dust or soil
- Playing close to the ground increases exposure to toxins in dust, soil, carpets, and low-lying layers of air

BIOLOGICAL

- Immature metabolic pathways are less able to detoxify and excrete certain toxins
- Rapidly maturing developmental processes are easily disrupted
- More future years of life allows more time for the development of chronic diseases caused by early environmental exposures

How can pesticides injure children?

The effects of pesticide poisoning on children can be acute and obvious, or chronic, cumulative, and subtle. The Consumer Product Safety Commission collects data on acute pesticide poisonings in the US, based on a statistical sample of emergency rooms in 6,000 selected hospitals.[11] From 1990 to 1992, an estimated 20,000 emergency room visits were the result of pesticide exposure. The incidence was disproportionately high among children, who accounted for 61%, or more than 12,000, of these cases.[11] Organophosphates were the class of compounds most frequently involved.

Acute high-dose exposure to organophosphate pesticides inhibits the enzyme acetylcholinesterase in the nervous system, leading to a spectrum of cholinergic symptoms, including lacrimation, abdominal cramps, vomiting, diarrhea, miosis, and profuse sweating. The more severe cases progress to respiratory arrest and death. Studies in animals indicate that young animals are more susceptible than adults to this acute neurotoxic

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syndrome, probably because the young are less able to detoxify and excrete organophosphates.

Concern about the chronic effects of pesticides focuses on two particular areas: subclinical neurotoxicity and disruption of endocrine function.

Subclinical injury. The notion of the possible "subclinical toxicity" of pesticides has gained increasing attention in recent years. This term denotes the idea that relatively low-dose exposure to certain chemicals, pesticides among them, may harm various organ systems without producing acute symptoms or being evident in a standard clinical examination. The concept arose from studies of children exposed to relatively low levels of lead who were found to have suffered loss of intelligence and altered behavior even in the absence of clinically detectable symptoms.[18] The underlying premise is that there exists a continuum of toxicity in which clinically apparent effects have asymptomatic, subclinical counterparts. It is important to note that these subclinical changes represent truly harmful outcomes and are not merely homeostatic or physiological "adjustments" to the presence of pesticides.[19]

Recent findings on the developmental toxicity of chlorpyrifos in animals illustrate the potential of pesticides to produce subclinical neurotoxicity in infants and children. The mechanism of chlorpyrifos-induced neurotoxicity appears to involve injury to the adenylyl cyclase cascade, a system in brain cells that mediates cholinergic as well as adrenergic signals.[20] Even at low doses of exposure, insufficient to compromise survival or growth, chlorpyrifos was found to "produce cellular deficits in the developing brain that could contribute to behavioral abnormalities."[21]

Because these animal data are so recent, studies of the developmental toxicity of chlorpyrifos in human infants have not yet been conducted. However, the animal data raise the concern that chlorpyrifos may not be the only organophosphate pesticide that could be a developmental toxicant in humans. The potential for such toxicity may be substantial in urban communities, where chlorpyrifos is heavily applied in closed apartments.[13]

On the basis of these findings, the EPA recently issued a ruling that bans the use of chlorpyrifos in schools, parks, and daycare settings and that prohibits and phases out nearly all residential use. Preventing developmental disability in children was the major reason for this ruling.

Endocrine disruption. The potential of pesticides to disrupt endocrine function has been recognized for nearly four decades, ever since the 1962 publication of Rachel Carson's *Silent Spring*. Carson's work showed that eagles and ospreys who had been heavily exposed to DDT had suffered disrupted estrogen cycles. As a result, these two predatory species at the top of the food chain were producing thin-shelled, nonviable eggs. Carson's work, along with the desire to prevent the bald eagle from becoming extinct, prompted the EPA to ban DDT in the early 1970s.

More recent evidence of the capacity of organochlorine pesticides to produce endocrine and reproductive toxicity in animals comes from studies of alligators in Lake Apopka in Florida, a body of water heavily contaminated with DDT and other organochlorines. Male alligators in Lake Apopka have been found to have significantly smaller penises than alligators from nearby uncontaminated lakes.[22]

Recent concern about the endocrine toxicity of pesticides in humans has focused especially on the pyrethroids, a class of insecticides widely used as substitutes for chlorpyrifos and other organophosphate and carbamate pesticides. Pyrethroids have been used in pediatric practice to control body lice and scabies instead of more toxic agents such as lindane, and their acute toxicity is generally low. However, hormonal activity has been reported for certain pyrethroids in laboratory systems, suggesting that their capacity to affect hormonal and reproductive development in children should be investigated further.[12] The pyrethroid sumithrin (Anvil) has been used recently in New York City and elsewhere on the East Coast in the spraying of mosquitoes to prevent the spread of West Nile Virus.

In fetal life, even low-dose exposure to endocrine-disrupting pesticides can have devastating effects, because hormones play critical roles in shaping the early development of the immune, nervous, and reproductive systems.[23] The developmental effects of exposure to endocrine disrupters vary depending on age at exposure and sex.

The Food Quality Protection Act of 1996 now requires that pesticides be tested for potential endocrine toxicity. Although much remains to be learned about the full range of this toxicity and its molecular mechanisms, the EPA has designed a new screening protocol for testing pesticides for endocrine-disrupting potential and will be making recommendations for safety standards based on these

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Revised EPA Handbook Now Available

The new revised version of EPA's pesticide poisoning handbook is now available The fifth edition of *Recognition and Management of Pesticide Poisonings* is edited by Dr. Routt Reigart and Dr. James Roberts, and is published by EPA's Office of Pesticide Programs. Both English and Spanish versions are available. The new edition covers about 1,500 pesticide products in an easy-to-use format. Toxicology, signs and symptoms of poisoning, and treatment are covered in 19 chapters on major types of pesticides.

This publication is free from the EPA. You can download it from the EPA website http://www.epa.gov/pesticides/safety/healthcare/handbook/order.htm . If you do not have access to the Internet, information on ordering is as follows:

For 5 or fewer copies:
Call EPA's Office of Pesticide Programs, at 703-305-7666 for individual copies.
Order from EPA by e-mail (pesticide-safety@epa.gov)

For larger orders:
Order by mail, telephone, fax, or online from NSCEP:
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tests. The endocrine toxicity of pesticides and other environmental chemicals promises to be a very exciting area of research in the next decade.

How do we protect children?

For fetuses, infants, and children alike, subclinical developmental neurotoxicity is the major threat posed by exposure to pesticides and PCBs. Evidence of that toxicity has become too great to ignore. The combination of young children's disproportionately heavy exposures to pesticides and PCBs, coupled with their developmental vulnerabilities, places them at increased risk for neurologic, endocrine, and other developmental disabilities.[4] Because these injuries cannot be reversed medically, prevention of exposure must be emphasized.[26]

Pediatricians can undertake a series of actions to reduce the exposure of children to pesticides:

- Counsel parents to minimize the use of pesticides in their homes and on their lawns and gardens. A rich literature on nonchemical alternatives to pesticides exists. Publications such as Organic Gardening offer many suggestions, and a nonchemical approach to pest control termed Integrated Pest Management (IPM) has been used extensively with considerable success.
- Urge parents to feed their children a balanced diet that includes a wide variety of fruits and vegetables. Also advise families to wash all fruits and vegetables, buy organic products, and serve fresh produce in season. In addition, while fruits and vegetables are certainly much healthier for children than sweets or fatty foods, encouraging families to rotate the diet to include different foods will further reduce pesticide exposure.
- Take action in local communities to encourage the reduction of pesticide use in schools and hospitals. Advocate that routine chemical pest control be replaced with IPM.
- Participate locally and nationally in the environmental health activities of the AAP. In this way, pediatricians have been very effective in advocating for stricter testing of pesticides prior to marketing and for limiting the use of the most dangerous pesticides, such as chlorpyrifos.
- Encourage families not to eat fish, crabs, and shellfish from waters known to be contaminated with PCBs and other persistent chlorinated organic compounds. This is the single most effective action for reducing children's exposures to PCBs. It is especially important that pregnant women and young women contemplating pregnancy not consume fish from such waters, given that PCBs from contaminated fish are well known to accumulate in fatty tissues, where they can persist for many years before crossing the placenta and reaching the fetal brain.

Education is the key to preventing both the short- and long-term effects of chemical exposure. By informing families about the risks of toxicity and ways to prevent exposures, pediatricians can help make a child's environment a healthier place, whether that environment is the great outdoors, the family home, or a mother's womb.

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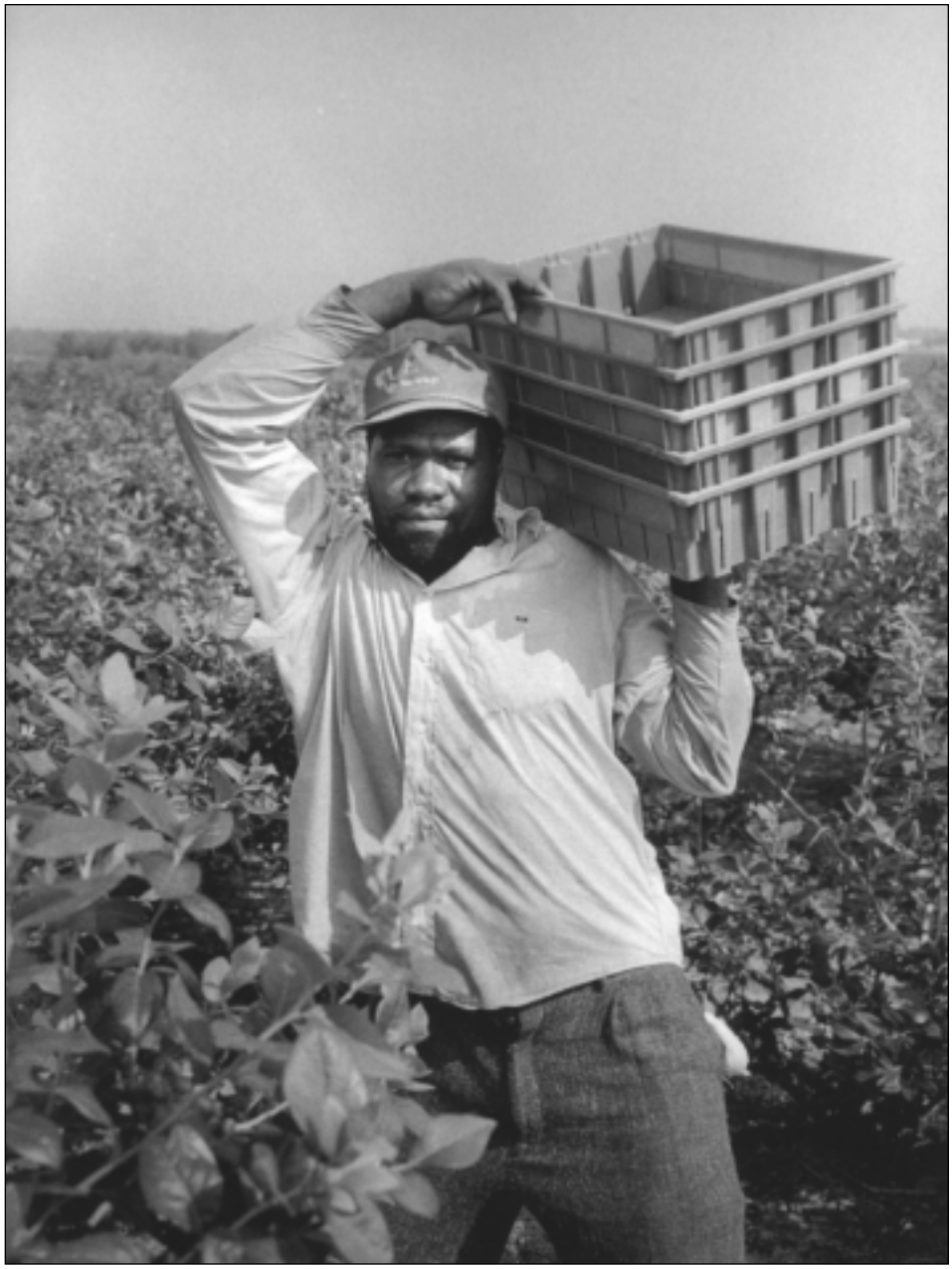
Comprehensive Diabetes Care for Mobile Patients

Diabetes is a leading chronic health condition among patients served by migrant/community health centers. A recent survey (summer 2000) of farmworkers in Michigan determined that 25% of the adults over age 20 had diabetes. [Personal communication, Willa Hayes, Northwest Michigan Health Services, Inc.] A Pennsylvania survey found a family history for diabetes in 50% of the 100 farmworkers interviewed. [Keystone Health Center report, Feb. 2001]

This is consistent with the National Diabetes Information Clearinghouse (NDIC) data on diabetes in Hispanic Americans; it cites a 25% prevalence in Mexican Americans and Puerto Ricans age 45 and older (US Dept. of Health and Human Services, National Institutes of Diabetes and Digestive and Kidney Diseases, NDIC). This prevalence rate is based on population based studies utilizing the NHANES III study (1988-94) and the HHANES study (1982-84) to determine the prevalence of diabetes among subgroups of Hispanic Americans. This rate is 2-3 times higher than that of non-Hispanic whites.

Hispanic women are more likely to have diabetes than are Hispanic men. Risk factors for diabetes include a family history of diabetes, gestational diabetes, impaired glucose tolerance, hyperinsulinemia and insulin resistance, obesity, and physical inactivity (US Dept. of Health and Human Services, National Institutes of Diabetes and Digestive and Kidney Diseases, NDIC). Again, these risk factors are more prevalent in Hispanic than non-Hispanic whites.

Mexican Americans have been shown to have higher rates of all complications from diabetes, with the exception of myocardial infarctions. While migrant-specific data are not widely available, this background on Hispanic Americans serves as a proxy; it is likely that migrant farmworkers, the majority of whom who would be classified as a subset of Hispanic Americans, experience even greater rates of disease complications due to occupational, socioeconomic, cultural and political factors. – From *Diabetes – Addressing a Chronic Disease in a Mobile Population*, MCN Monograph, 2001



To address this issue, MCN has developed a comprehensive diabetes assistance program for patients and providers. The components of this program are outlined in this article.

Collaborative

MCN is a National Partner in the Health Disparities Collaboratives. In this capacity, MCN serves as expert faculty at learning sessions; provides technical assistance on listserves; participates in steering groups, conference calls, and strategic planning; and develops resources for health center teams in the Collaboratives. Trainings have included sessions on cultural competency in the context of self-management and resource development for the migrating patient. A resource pack for providers

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caring for migrant populations with diabetes is available to teams and is detailed below. MCN continues to pursue partnerships with national business and health organizations in order to secure improved access to care, services, and medications for farmworkers with diabetes.

Medical Records Assistance Programs

Continuity of care is a health care challenge faced by migrant workers. MCN has developed two programs to help facilitate more continuous and structured care for migrant patients. TB*Net* (for tuberculosis treatment) began in 1996 and has enrolled nearly 1200 patients. Diabetes Track II began in 2000 and has enrolled over 200 patients.

These programs transfer vital health information and support mobile patients as they implement their treatment plans.

Clinicians throughout the United States and Mexico can call MCN's 1-800 number to request copies of a patient's medical records, which are stored in MCN's main office. These records are then faxed or mailed to the clinic, health department or provider.

Patients use the 1-800 number to request help finding medical services such as the name and location of the nearest clinic, programs that help cover the cost of medications, etc.

Any health care provider can enroll patients. All that is required is a phone or in-person training by MCN program staff. Any provider who sees a Track II or TB*Net* patient can request the patient's medical records (even if the provider isn't enrolling patients). There is no charge associated with either enrolling patients or receiving medical records.

Diabetes Resource Pack

The Diabetes Resource Pack was created as a mechanism for distributing information

MCN's Diabetes Program

- Work with the Collaboratives to highlight migrant issues
- Medical Records Assistance
- "Diabetes – Addressing a Chronic Disease in a Mobile Population" MCN Monograph
- Resource Pack
- Moving Pack
- Look for links to other diabetes sites and more information on our website — *www.migrantclinician.org*

on migrant diabetic care to members of the Diabetes Collaborative. The pack can be ordered from MCN or items may be ***downloaded free from our website***. If the pack is ordered, it contains a video (in English or Spanish), 3 disks of information and paper copies of items that we do not have in an electronic format.

Clinics, Diabetes Control Programs and individual providers have found the resource pack a valuable tool. New information is added frequently.

Moving Pack

MCN diabetes staff created the Moving Pack to provide an additional tool to

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Resource Pack Contents

(These can all be downloaded from MCN's website www.migrantclinician.org or ordered by phone at 512-327-2017)

Track II Information

Moving Pack

Provider Training Folder
- Case Histories
- Medical Spanish Training Opportunities
- Literacy Level Guides
- Alternative Medicine Use
- Managing Diabetes in the Migrant Setting

Vision Partners folder
- Mission Partner Memo
- Vision Resources
- Vision Station – FAQs

Other Tools
- Sample Diabetes Calendar
- Migrant Care Model
- MCN Care Model Resources
- Spanish Depression Screening Tool (HANDS)
- HbA1c Patient Education Tool (Spanish)
- Ideas for Obtaining Glucometers
- Internet Resources
- Self Management Packet Cover Sheet (Spanish)
- Diabetes ID Program
- Medication Assistance Programs
- Worksite Diabetes Information Card
- Sample HbA1c Reminder Postcard (Avery #8387)
- ***New!*** Migrant Flow Sheet: English, Spanish

Footcare Folder
- LEAP Foot Screening Tool: English, Spanish
- LEAP Self Test Instructions: English, Spanish
- Patient Booklet Instructions (English)
- Foot Care Resources

CALENDAR

The Western Stream Forum
February 1-3 2002
Sacramento, California
Contact Wendy Nitta at the
Northwest Regional Primary Health Care Association
206-783-3004
fax: 206-783-4311
wnitta@nwrpca.org

MAFO National Farmworker Conference
February 18-21, 2002
San Diego, CA
Contact: Lalo Zavala 320-650-1711
www.mafofarmworker.com

7th Conference of the IUATLD North American Region
Vancouver, Canada
February 28- March 2, 2002
for more information — *info@bc.lung.ca*
(604)731-5864

International Conference on Emerging Infectious Diseases
Atlanta, Georgia
March 24-27, 2002
for information — *meetinginfo@asmusa.edu*
(202) 942-9248

16th Annual California Conference on Childhood Injury Control
September 23-25, 2002
Sacramento, CA
Califnorai Center for Childhood Injury Prevention
619-594-3691
www.cccip.org

2002 National Conference on Health Care and Domestic Violence
September 26-28, 2002
Atlanta, Georgia
Family Violence Prevention Fund
(415) 252-8900
www.endabuse.org/health/CFA

Comprehensive Diabetes Care for Mobile Patients

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clinicians who serve migrant workers with diabetes. The information in the Moving Pack is provided in English and Spanish at a basic reading level. There is information specific to the concerns of patients in the process of moving.

We encourage clinics to personalize Moving Packs if they create them. In the original MCN Moving Packs we included a clinic directory and key-chain from the National Center for Farmworker Health and a "Living with Diabetes" flyer from the Texas Department of Health Diabetes Program.

Other ideas of things to include:

- Coupons for healthy foods
- Information about your clinic
- Hard candy to be used in cases of hypoglycemia
- A copy of the patient's medical records

We used 6½ X 9½ inch envelopes for the packs, but any sort of bag or envelope would work.

For more information about MCN's Diabetes Program and Resources go to our website, *www.migrantclinician.org*, order our new Monograph "Diabetes – Addressing a Chronic Disease in a Mobile Population", or contact Carmel Drewes at 512-327-2017, *carmel@migrantclinician.org*.

Contents of Moving Pack

(These can all be downloaded from MCN's website www.migrantclinician.org or ordered by phone at 512-327-2017)

- Sticker Labels for front of packet: one (Avery 5168 labels), two (Avery 5164 labels)
- Basic Guide to Healthy Foods: Black&White, Color
- Diabetes Care while Traveling: Black&White, Color
- Daily Footcare Flyer: Black&White, Color
- "I have Diabetes" card
- Diabetes Worksite Info
- Diabetes Necklace Info (for more information about the Diabetes Alert Necklaces, visit the Diabetes Research and Wellness Foundation)
- Track II Info
- Return Postcard
- Stickers to put on a fast food restaurant Nutritional Guide (both on Avery 5164 labels)

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