Washington State Department of Health

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Contributing Factors to Pesticide Related Illness among Agricultural Workers in Washington State, 2003-2008

Background

The Department of Health's Pesticide Program investigates reports of illnesses related to pesticide exposure. We use data collected from these investigations to identify public health problems and develop strategies to prevent human exposure to pesticides. Federal and other state agencies, local government, advocacy groups, and legislators also use the data for similar purposes.

Sources of Case Reports

The Department of Health receives reports of suspected pesticide illness events from numerous sources, including Washington Poison Center, the Department of Labor and Industries (L&I) Claims Administration Program, the Washington State Department of Agriculture (WSDA), health care providers, and others. More than one agency may report the same illness event. An event may involve exposure to one or more individuals. Each individual exposure is investigated by Pesticide Program staff members as a separate case.

Case Investigation Criteria

Any single event that is reported may involve multiple people who experience pesticide illness. We review all referred reports and investigate those which meet the following criteria:

- A pesticide exposure is reported.
- Symptoms are reported.
- At least one individual involved saw a health care provider.
- The pesticide exposure occurred during the last three months.
- The pesticide exposure occurred in Washington State.
- The pesticide exposure was neither a suicide nor homicide attempt.

The Pesticide Program occasionally investigates cases of special circumstance even if all criteria are not met. Examples are: unusual exposures to children, incidents involving multiple ill people, moderate to severe illness or injuries for which the individual did not seek health care, and cases referred by another state agency for co-investigation with the Department of Health. Although many disinfectants are regulated as pesticides under federal law, we do not currently investigate disinfectant-related injury unless the product is specifically being used as a fungicide (for mold control).

Classification of Investigated Cases

The Pesticide Program investigators interview individuals, obtain pesticide application and medical records, and, at times, conduct field visits. Investigators use these data to determine the likelihood that reported symptoms are related to a pesticide exposure. Investigators classify cases using documentation of exposure and health effects, and evaluation of the causal relationship. We use the National Institute for Occupational Safety and Health (NIOSH) Case Classification System to distinguish between Definite, Probable, Possible (DPP). Other classification categories also include Suspicious, Insufficient Information, and Unlikely cases. Minimum criteria for assignment to DPP classifications include: symptoms are characteristic of known toxicological effects of the pesticide, and the time between exposure and symptom onset is consistent. Further description of DPP cases is provided in Table 1. Numbers of DPP cases for the years 2003 through 2008 are shown in Table 1.

Table 1. Classification Criteria of Definite, Probable, and Possible Cases

	Evidence of Exposure	Evidence of Health Effects
Definite	Laboratory, clinical, or environmental evidence corroborates exposure, and →	Two or more post-exposure health effects (one a sign*) or lab findings are reported by a licensed health care provider.
Probable	Laboratory, clinical, or environmental evidence corroborates exposure, and →	Two or more post-exposure symptoms** are reported by the individual or a health care provider.
	Evidence of exposure is based on report from case, witness, application, observation of residue or contamination, and →	Two or more post-exposure health effects (one a sign) or lab findings are reported by a licensed health care provider.
Possible	Evidence of exposure is based on reports from case, witness, application, observation of residue or contamination, and →	Two or more post-exposure symptoms** are reported by the individual or a health care provider.

**Signs are considered objective evidence of illness and are observable on examination by a health care provider (e.g. low heart rate, cough, rash, depressed cholinesterase activity).*

***Symptoms are considered subjective evidence of illness and may not be observable on examination by a health care provider (e.g. headache, nausea, dizziness).*

Table 2. DPP Case Classification, 2003 – 2008

Classification	2003	2004	2005	2006	2007	2008
Definite	69	63	49	21	36	48
Probable	53	55	48	39	63	90
Possible	62	86	91	89	108	114
Total DPP Cases	***184***	***204***	***188***	***149***	***207***	***252***
All Cases Reported	275	269	252	254	310	310
Percent DPP	67%	76%	75%	58%	67%	81%
Percent Insufficient Information	17%	14%	17%	22%	18%	7%

Underreporting

The number of DPP cases documented by the Pesticide Program is an underestimate of the actual number of pesticide-related illness and injuries that occur in Washington each year. Our surveillance system captures mainly cases that seek medical care and for which the health care provider either calls the Washington Poison Center and/or files an L&I industrial insurance claim.

Many people with mild symptoms do not seek health care. Poison Center data provides a limited measure of this. Most of the pesticide-related calls that the Poison Center reports to us through the Pesticide-Illness Electronic Reporting System (PIERS), are from people that did not seek health care. As such, they failed to meet our criteria for investigation. Medical outcome of these calls were mostly coded by Poison Center staff as “minor effect” or “not followed, minimal clinical effect possible.”

Occupational cases in our data set may be similarly under-represented. Workplace exposures are generally reported through L&I, not the Poison Center. During focus group meetings with farm workers in the Yakima area in 2001, workers explained that they would not likely take time off from work to seek health care for mild to moderate symptoms[1]. They are also unlikely to self report to a government agency, voicing concerns about possible detriments to their job security.

In addition, there is under-reporting from health care providers.

- Providers may not recognize the symptoms as being pesticide-related.
- Providers may not know to report.
- Providers may decide that other clinical responsibilities take precedent.
- The patient’s employer may be self-insured so claims would not be submitted to L&I.

Currently there is no good estimate of the extent of health care provider under-reporting in Washington. In a Department of Health study completed in 2004, our pesticide illness surveillance captured about 60 percent of occupational illnesses that sought medical care in the Yakima area and were given a pesticide-specific diagnosis[1]. Farming employers are primarily insured through L&I, so the percentage of capture of health care visits for occupational pesticide-related injuries may be relatively higher in this region. No state studies have been done to estimate the number of health care visits for urban residential pesticide exposures that go unreported.

[1] See “Improving Data Quality in Pesticide Illness Surveillance” June 17, 2004, at www.doh.wa.gov/ehp/oehas/publications_pdf/improving_data_quality_in_pesticide_illness_surveillance-2004.pdf.

Passive surveillance programs never capture every case. Their strength is in capturing enough cases to understand what problems are occurring and why. The focus of our pesticide illness monitoring is to collect data for targeted prevention. Although it is possible that our surveillance is missing significant cases, we are documenting enough problem areas to be able to conduct prevention activities.

Identifying Contributing Factors to Pesticide-Related Illness among Agricultural Workers (2003 – 2008)

In June 2010, the Department of Health completed a five-year grant from the National Institutes of Occupational Safety and Health (NIOSH) to better identify root causes for pesticide illness and injuries among agricultural workers. Multiple research studies in WA State have showed this population to carry a higher burden of pesticide exposure than the general population and they represent 30% of our total DPP acute cases of pesticide-related illnesses. This was a supplemental grant to improve pesticide illness surveillance with an emphasis on understanding the root causes of 1) improper personal protective equipment (PPE) practices and 2) pesticide drift. The project had several components:

1. Monitor the frequency and nature of contributing factors for pesticide-related illness among agricultural workers. *Method*: We added questions in our regular interview to understand why exposures occurred and developed new coding to track responses. We also coded two preexisting years of cases (2003 – 2004) using information in the case file.
2. Identify specific PPE problems that contributed to pesticide-related illnesses and injury. *Method*: We recorded as much detail about the specific nature of PPE problems noted in the case investigation. We coded major categories of PPE problems and added text fields to record further detail about why the problem existed.
3. Identify specific contributing factors in incidents involving pesticide drift. *Method*: we developed a one-year inter-agency checklist to solicit additional information on possible factors that contributed to drift to workers. We also added a text field to record as much detail as possible from the investigations of Health and enforcement agencies during the other years of the grant.

Findings

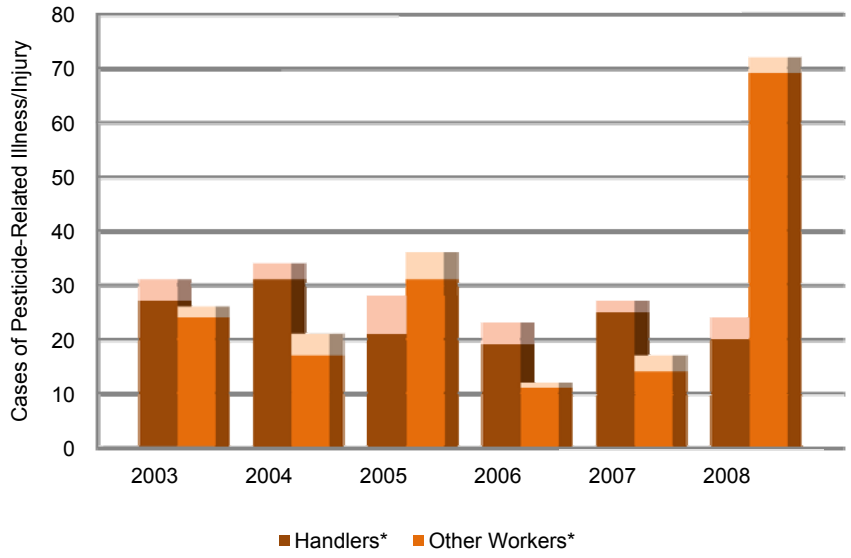
From 2003 through 2008, we documented 351 cases of agricultural workers with an illness or injury plausibly[2] related to occupational pesticide exposure (Figure 1). Medical outcomes were mostly mild in severity. Handlers had a higher percentage of moderate to severe outcomes

[2] Cases of illness or injury classified by Health Pesticide Program as definitely, probably or possibly related to pesticide exposure.

(14%) compared to other workers (10%). We did not identify any deaths from occupational exposure among agricultural workers during this time period.

Pesticides handlers were identified using the EPA Worker Protection Standard (WPS) definition of “handling.” Handlers were mixing, loading, or applying pesticides; cleaning or fixing contaminated equipment; or handling open pesticide containers. Other workers were harvesting, thinning, moving irrigation pipes, or doing other agricultural work. Only cases classified as definitely, probably, or possibly due to pesticide exposure are included.

Figure 1. Department of Health pesticide-related illness cases among agricultural workers from 2003-2008



**The lighter shade represents workers with moderate to severe injury or illness.*

Health tracked 16 different underlying factors that contributed to over-exposure (Table 3). Among pesticide handlers (*n*=167), the leading contributing factors were lack of required personal protective equipment (PPE) and other PPE problems. Among other agricultural workers (*n*=184), pesticide drift was the leading factor in their over-exposure.

Table 3. Contributing factors to pesticide-related illness among agricultural workers (2003 – 2008)*

Contributing Factors Identified	Handlers (*n*=167)	Other Workers (*n*=184)
Posting or notification didn't occur	2	20
People were exposed in the treated area during application	1	15
Structure not adequately ventilated before allowing people to re-enter	1	0
Early re-entry	0	19
Required eye protection not worn	42	2
Other required PPE not worn	43	5
PPE in poor repair, not maintained, not worn correctly	29	1
Spill or splash (not involving equipment failure)	27	2
Product not stored properly/ within reach of children	0	1
Decontamination not adequate or timely	14	2
Intentional misuse of a pesticide to cause harm	0	1
Other label violations identified	8	4
No label violation identified but person still became exposed/ill	53	41
Equipment failure	22	2
Drift	3	101
Applicator not properly trained and/or supervised	24	7
Other	1	7
Unknown	15	7

**More than one factor can be coded for each case so the columns do not add to the total cases from each category of agricultural worker.*

We analyzed contributing factors for handlers separately from other workers since these groups often access different venues for training in Washington State. Handlers are educated mainly through pesticide license recertification classes and on-the-job training provided by licensed applicators. Other workers are reached through on-the-job training required by WPS, radio shows, community services, and health fairs. Employers may want to emphasize different prevention messages when training their handlers and their harvesting crews. Public health and worker protection programs at the Department of Health, L&I, and WSDA, may want to incorporate the prevention messages most specific to their outreach audience.

Agricultural Pesticide Handlers (*n*=167)

PPE problems that contributed to exposure (*n*=93 workers)

Fifty-six percent of handlers were missing at least one piece of required PPE (68 handlers) or had another identified problem with their PPE (29 handlers)[3]. Forty-two workers were missing required eye protection, and 43 were missing another piece of PPE: gloves (*n*=31), respiratory PPE (*n*=15), rubber roots (*n*=6), and apron when mixing (*n*=4). Seventeen workers were missing both eye PPE and another required piece of PPE. Four workers were missing at least one piece of PPE and also had a problem with PPE that they were wearing.

Table 4. PPE Problems that contributed to exposure

Contributing Factor Identified*	Total # workers with problem**		
Missing eye PPE	42	68 workers with at least one piece of missing PPE	93 workers with some PPE problem
Other required PPE not worn	43		
PPE in poor repair, not maintained, not worn correctly	**29**		

**This represents only those cases where the missing PPE contributed to their exposure. If the person was missing eye protection but had an exposure on their foot, missing eye PPE would not have been coded as a contributing factor.*

***The last two columns adjust for multiple contributing factors coded for some workers.*

We recorded a reason in 68% of the cases of missing PPE. The leading reasons given for missing PPE were that the employer didn't provide it (*n*=10) or that handlers otherwise did not think PPE was needed (*n*=9). In 8 cases, the handler was wearing an inadequate type of PPE (such as sunglasses instead of safety glasses, cotton instead of rubber gloves). In seven cases, the handler removed PPE to clean a sprayer, fix a plugged nozzle, or itch their face.

[3] *This represents only those cases where the missing PPE contributed to their exposure. If the person was missing eye protection but had an exposure on their foot, missing eye PPE would not have been coded as a contributing factor.*

Table 5. Primary Reason Report for Missing PPE

Primary Reason Reported for Missing PPE	(n=68)
Employer did not provide	10
Didn't think it was needed	9
Wearing wrong type	8
Label not explained/poorly supervised	2
Removed to clean or fix equipment	6
Did not wear due to heat	5
Removed to scratch eye/nose	2
Forgot to use	1
Other	3
Unknown	22

In 24/68 cases (36%), the worker was exposed while doing a handling task that was not strictly mixing, loading, or spraying but which is considered handling by WPS. Examples are: cleaning application equipment after an application, fixing contaminated equipment, moving open containers, supervising a handler in the treated area, and unclogging a nozzle or adjusting valves midway through an application. We suspect that these workers were unaware that handler PPE was required for these tasks under WPS or were not motivated to wear PPE for tasks they perceived as having low risk of exposure.

Exposures to unexpected spill or splashes were co-factors in 26/68 cases (38%) in which the handler was missing required PPE. Half of these 26 cases were due to some type of equipment failure. This observation could be used to motivate workers to guard against unexpected splashes by wearing their PPE for all tasks where direct exposure is possible. Another co-factor identified in 26% of cases with missing PPE was lack of training and supervision. This would include cases where the supervisor did not provide PPE, did not instruct the handler to wear PPE, or did not provide initial training or instruction.

Twenty-nine handlers were wearing PPE with some identified problem. These were largely issues with respirators and goggles. In eight cases, the respirator cartridge was not changed frequently enough or had an incorrect filter. Cartridge change-out problems were noted if the worker reported smelling chemical through the mask or long periods (days to weeks) between cartridge replacements. In four cases, the handler was wearing a damaged respirator. In six cases, the respirator had a poor fit. In five cases, the goggles had a poor fit. Poor fit was coded if the worker mentioned that the seal of the respirator opened on the side when they turned their head, or that the goggles let mist or drips in through the seal. Poor fit was also coded if co-investigation by another agency documented an improper fit.

A “respirator fit-test” is required at least once to confirm that the brand and size of a worker’s respirator seals well over the shape of his face. In addition, a fit check is done each time the worker dons the respirator in order to detect improper seal due to loose straps, a faulty valve, or facial hair interfering with seal of respirator. The seal should not break when the worker moves his head in any direction. Many of the PPE problems identified could be addressed by attention to proper cartridge change-out and daily fit checking of respirators.

Spill and splashes (*n*=49)

Table 6 shows the cases for which spills and splashes were identified as a contributing factor. Cases are coded under two categories depending on whether failure of spray equipment was involved.

Table 6. Spills and Splashes Identified as Contributing Factors

Contributing factor	Applicators	Mixer/Loaders	Repair and Maintenance	Totals
Spills and splashes not involving equipment failure	6	15	5	**27***
Equipment failure	14	1	7	**22**
Totals	***20***	***16***	***12***	***49***

**Total for this row includes on an additional worker who was transporting pesticides.*

Spills and splashes were factors in 29% of the handler cases. Nearly half (45%) were due to equipment failures. The most common problems for applicators were ruptured spray hoses (*n*=7) and hoses and valves failing when the tank pressure was increased (*n*=3). The most common problem for mixers and loaders was eye injury from splashes not involving equipment failure (*n*=11). In eight of these cases, the handler was missing eye protection. The most common exposures for workers repairing or maintaining equipment occurred when unclogging nozzles (*n*=6) and washing sprayers after application (*n*=5). Cases in which spray mist blew back on the handler during the application were not included under spills and splashes.

Protection from spills and splashes should focus on 1) proper inspection and replacement of sprayer hoses, valves, and nozzles; 2) splash protection for eyes and face when mixing and loading pesticides; and 3) ensuring that workers understand that cleaning sprayers and repairing valves and nozzles are handler tasks and require handlers PPE at a minimum. Handlers should wear splash protection for their face whenever they make adjustments or repairs to pressurized spray equipment. Increased adoption of closed mixing systems and water soluble packets would also minimize splashes during mixing.

Lack of training and supervision (*n*=24)

Poor training or supervision was coded as a contributing factor in 14% of all handler cases. This probably underestimates the problem since we did not directly ask about training or supervision in most cases. These cases represent only the cases where the worker reported lack of supervision as a contributing factor (10 cases) or where we noted an obvious lapse in supervision or training. Often there were multiple errors involved. Examples are: supervisor didn't provide required PPE, worker continued to work in soaked clothing after pesticide leak because he was unaware of the chemical hazard, supervisor gave the handler unsafe work instructions, and handler was unable to read English yet no one explained the label to him. Lack of training and supervision was often a cofactor with missing PPE (19 cases) or spills and splashes (8 cases). Twenty of these 24 handlers were not licensed. Licensed applicators who supervise handlers should make sure all required PPE is worn and that handlers fully understand the potential for injury in their assigned tasks.

No label violation but handler still became ill (*n*=53)

This code was used when the handler appeared to have complied with the PPE requirements but was still exposed with resulting injury. In a small number of cases, it appears that the handler had a sensitivity or allergic reaction to the spray. In 21 cases, the required eye protection did not protect the handler when a splash occurred or equipment broke. There are four ways to meet EPA's requirement for eye protection: safety glasses with side, brow and bottom protection; goggles; face mask; and full-face respirator. Safety glasses in particular were not effective in protecting against splashes or wind-blown spray mist.

At least one scenario was reported eight times and should be explored further to determine if the label is sufficiently protective. Handlers driving air blast sprayers in orchards frequently reported that they are exposed on their face and neck when they turn the tractor at the end of the row. This is partly due to turning their heads to look back at the sprayer during the turn. In addition, they may drive back through spray mist as they start the next row. This included one worker with 80% depression in cholinesterase activity who was wearing a fit-tested respirator, full PPE, and whose only reported exposure was that he sometimes smells and feels chemicals on his skin at the end of the rows. The eight handlers are in addition to six workers (coded as having a PPE problem) who specifically reported that their goggles or respirators did not seal tightly to their face when they turned their heads at the end of the row.

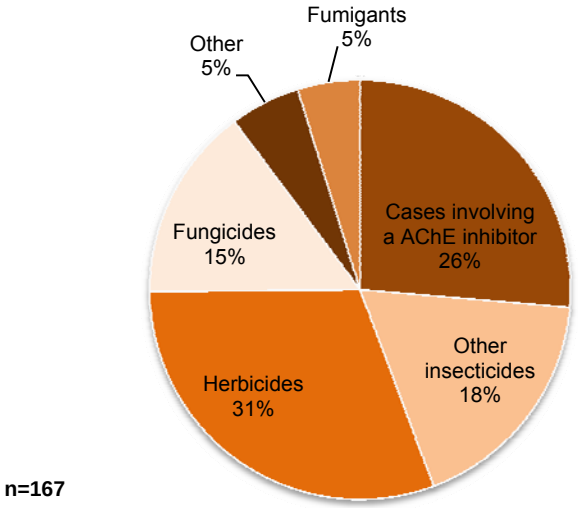
Pesticide drift (*n*=35 applications)

Pesticide drift was not a frequent cause of handler exposure but handlers are responsible to ensure that pesticides do not drift and contact other workers. Handlers and their supervisors should take note of the contributing factors for pesticide drift outlined on the next page.

Type of pesticide (*n*=167 handler cases)

Forty-four percent of handler cases involved exposure to an insecticide either alone or in combination with fungicides and other pesticides. Over half of these insecticide cases involved exposure to an acetylcholinesterase (AChE) inhibitor such as chlorpyrifos, azinphos-methyl, phosmet, dimethoate, or carbaryl. Herbicides, such as glyphosate, paraquat, and 2-4, D, were involved with 31% of cases. Fungicides are frequently tank mixed with insecticides and are under-represented visually in Figure 2. Fungicides applied alone or in combinations were associated with 15% of handler cases. When we add the fungicides tank-mixed with insecticides, a total of 32% of the handler cases involved exposure to a fungicide. Common fungicides were sulfur compounds, mancozeb, and captan.

Figure 2. Type of Pesticide Involved with Handler Cases



Other characteristics: Handlers in this data set were 98% male, 83% Hispanic, and 73% preferred to communicate in Spanish. Median age was 33 with range of 16-74 years old. Most were exposed while applying pesticides (75%). Ten percent were mixing or loading at the time of their exposure, 10% were repairing or maintaining equipment, three workers (1.5%) were transporting pesticides, and six workers (3.5%) were doing some combination of these handling tasks. Seventeen percent of handlers were licensed pesticide applicators, 57% reported to be working under the supervision of a licensed person, and 15% were not licensed. License status was unknown in 5% of the handler cases and not applicable in 6% of cases (no application taking place). Most frequent crops associated with handler cases were tree fruit (59%), potatoes (6%), hops (6%), berries (6%), nursery and ornamentals (5%), and grapes (4%), and cereal grains (2%). Ground sprayers (primarily air blast sprayers) were associated with 65% of handler exposures. Backpack sprayers accounted for 6%, power

sprayers with handheld spray lines (6%), and manual placement of baits or fumigants (5%). All other equipment categories were 3% or less including aerial applications.

Other Agricultural Workers (*n*=184)

Pesticide drift (35 incidents involving 104 workers)
Drift from agricultural pesticides is a persistent source of documented illnesses. In this six-year period, 80 incidents involving 191 people were considered by the Pesticide Program to be plausibly related to agricultural pesticide drift. More than half of these incidents involved drift to bystanders or workers outside agriculture. Thirty-five incidents, exposing three handlers and 101 other agricultural workers, are described below.

All 35 incidents involved pressurized application equipment. Five incidents involved aerial applications; the rest were ground sprayers. Two-thirds of the incidents (23/35) involved air blast sprayers in orchards. No other crop had more than two drift incidents involving workers. Since differences in acres planted do not explain the higher frequency seen in tree fruit, we need to understand the factors that make drift-related illness more likely in orchards workers. One possible explanation is the acute toxicity of the products used in orchards. Twenty of 23 orchard incidents involved insecticide exposures; seventy percent of these were cholinesterase inhibitors. Another factor may be the high pressure fan-shaped spray produced by the typical orchard air blast sprayer. Drift research has shown that fine droplets produced by this type of equipment are prone to drift. Our data suggest that drift-related illness among agricultural workers should decrease with continuing efforts to replace the most acutely toxic products in tree fruit and to modify or replace air blast sprayers.

Other factors which appeared to contribute to drift were: proximity of workers to the spray equipment, inadequate communication, and in at least 4 incidents, windy conditions. In most of the drift incidents the workers could see or hear a sprayer nearby. In 12/35 incidents, the reported distance between the worker and the sprayer was less than 50 meters or the worker was in the block/field being treated. In another 17 incidents, workers were in an adjacent block/field or at the edge of the block. When asked why workers were close to sprayers or in the same spray block, we often heard that they were not notified about the sprayer and were not sure they were permitted to leave their work when the drift reached them. In five incidents, the applicator saw the workers but thought he was a safe distance from them. In ten incidents, the sprayer worked for a neighboring farm. Adjacent farms are not required to notify each other when treating their perimeter fields but such notification could help keep workers a safe distance from pesticide applicators.

Workers present in the treated area during application (*n*=15)
or exposed during early re-entry (*n*=19)

In 15 cases, workers were in the target area during the application. This resulted in exposure to direct spray or drift from nearby sprayers. Examples are a mechanic who was sprayed aerially while fixing an irrigation pump, farm workers who received direct spray when a speed sprayer passed one row away, and a dairy worker who worked in the same room as an automated insecticide mister. Poor communication or lack of notification appeared to be a factor in half of these cases. Examples are a mower who was surprised when a sprayer began working in the same area of the orchard and an apple packer who received spray in her face when a sprayer passed one row away. Farms need ongoing communication between pesticide applicators and other work crews to keep unprotected workers out of harm's way.

Early re-entry into a treated area was identified as a contributing factor in 19 cases (18 incidents). In several cases, neither the employer nor the workers were aware of the early re-entry before we compared the investigation notes with the pesticide application records. There were eleven early entries on 12-48 hrs restricted entry intervals (REIs), and five early reentries on 14 day REIs. Again, communication problems appeared to be an underlying factor in 11/19 cases. Crop advisors and irrigators did not see posted signs, other workers reported that they did not see posted signs and were following verbal instructions from supervisors. In one case, a crew of workers had already been sent to an area when the employer realized that an REI was still in place and moved the workers. The workers had not noticed any signs. Fields need to be posted according to the label and WPS. Since field workers rely on verbal instructions from their supervisors, a central system of tracking needs to be maintained so that supervisors do not assign workers to areas that are restricted.

Other characteristics: Other workers in our six-year data set were 61% male, 89% Hispanic, and 82% preferred to communicate in Spanish. Median age was 32 with a range of 14-65 years of age. Workers were predominantly working in tree fruit (67%) at the time of exposure. Activity at the time of exposure was fruit harvesting (65 workers), thinning (28 workers), general orchard work (23 workers), nursery work (18 workers), irrigators (9 workers), field crop work (9 workers), fruit tree pruning (8 workers), and vineyard work (7 workers). One large drift incident in 2008 involved 46 fruit harvesters. If we remove this incident from the analysis, thinning is actually the most common activity among other workers associated with pesticide-related illness. Application equipment associated with exposures to other workers were 58% ground sprayers (mostly air blast sprayers) and 29% aerial sprayers. Again, 46 workers in one incident were exposed to a single aerial application. If we subtract this incident, 89% of cases were related to ground sprayer equipment.

Limitations

Information on contributing factors was largely collected through phone interviews with workers who had become ill or injured. We did not routinely contact employers to confirm that the information was consistent with their understanding of the event. Since the worker is not initiating the call to the Pesticide Program and often does not want us to contact his or her employer, we are limited by information that is one-sided. We do see the pesticide application records and the findings of enforcement agencies if the case was co-investigated but the information should still be considered incomplete. The information is collected for the sole purpose of guiding prevention.

Conclusions

Pesticide Drift

Agricultural pesticide drift was a source of exposure for 30% of the workers with DPP illness or injury in this six-year period. Most of these workers were engaged in thinning, harvesting, pruning, or irrigating at the time of exposure. We identified several preventable factors that contribute to agricultural pesticide drift:

- Inadequate communication between applicators and other workers or neighbors.
- Proximity of application equipment to workers, roads, and homes.
- Use of equipment that is prone to drift (such as orchard air blast sprayers).
- Use of fumigant and other acutely toxic products.
- Application during unfavorable weather conditions.

Personal Protective Equipment

Missing required PPE was a contributing factor in 41% of handler cases documented. Top reasons for missing PPE were that employer didn't provide it, handler didn't think it was needed for the task, and handler removed PPE to clean or fix equipment.

- Employers need to provide all PPE required on the pesticide label and ensure their handlers wear it.
- Handlers need to wear handlers gear when cleaning and fixing contaminated equipment, moving open containers, transferring pesticides, or anytime they are doing tasks in an area being sprayed.

PPE problems such as poor fit, delayed change-out of respirator cartridges, and wearing damaged PPE, were documented in 17% of the handler cases over a six-year period.

- Many of the PPE problems identified could be addressed by attention to proper cartridge change-out and daily fit checking of respirators. Handlers should conduct a negative and positive pressure check every time they don their respirator.

- Both goggles and respirators should maintain their seal to the face when the handler's head turns to the side.

Prevention Messages by Target Audience

We have organized our key findings by target audience for easy incorporation into prevention activities. These are shown below.

Key Prevention Messages by Target Group

Male Hispanic Handlers (in Spanish)	• Important to wear all required PPE (especially goggles, gloves)
	  ▪ Employers must provide you with what the label requires.
	  ▪ Wear for all handling tasks including cleaning spray equipment.
	  ▪ Always wear splash protection when adjusting or fixing pressurized equipment.
	• Check the fit of your goggles and respirator every time.
	• Spray drift from air blast sprayers can travel far especially when trees are bare. Make sure thinners and other workers are a safe distance.
	• Communicate spray plans with foremen of other work crews and irrigators on the farm.

Male and female Hispanic field workers (in Spanish)	• If a sprayer comes into your work area, find your foremen and move. • Report drift to your foremen and decontaminate exposed skin and clothes.
Agricultural Employers/foremen	• Provide workers with all PPE required on pesticide label. • Supervise handlers to ensure they wear PPE and wear it correctly. Ensure proper respirator cartridge replacement. • Unlicensed handlers need close supervision. • Keep workers out of harm's way: facilitate communication between spray crews and others. • Notify neighbor farms when spraying blocks along the property line. • Post treated fields with required warning signs throughout the re-entry period. • Track REI's centrally at the office where work is assigned; ensure that crews and irrigators are not verbally directed to work in areas before REI has expired.
EPA	• Review REI's to ensure they are protective. • Give guidance for safe distance from orchard air blast sprayer. • Continue to encourage alternatives to acutely toxic pesticides. • Review worker exposure assumptions for handlers on air blast sprayers.

Prevention Activities

Dissemination of this information is crucial to prevention. The Pesticide Program shared this information with health care providers, farm workers, and at trade association and other industry meetings. For example, the Department of Health presented to health care providers at the Western Migrant Stream Forum in Seattle, WA in 2010. We coordinated with representatives from the Washington State Farm Bureau to provide this information to their constituents and there is ongoing collaboration with Washington State University, L&I, WSDA, and other agencies to present our findings to pesticide handlers and agricultural supervisors.

We have also collaborated on a meta-analysis of risk factors with WSDA, L&I, and the Pacific Northwest Center for Agricultural Safety and Health (PNASH) at the University of Washington. Our goal is to develop integrated prevention messages and strategies for agricultural employers and employees.

For more information about this report, contact the Washington State Department of Health's Pesticide Program at http://www.doh.wa.gov/pesticidecontact**.**

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