A Training Method Pairing Epidemiological Research Results with Pesticide Safe Handling Recommendations to Improve Pesticide Applicators' Personal Safety Practices

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Abstract

Extension educators seek to effect positive behavioral changes in reducing pesticide exposures. Maryland and Washington Pesticide Safety Education programs incorporated Agricultural Health Study (AHS) research results in an audience response presentation. The AHS findings served as potential motivators to influence behavioral changes. The presentation was designed to avoid overstating risk messages to applicators not involved in the studies, and to emphasize applicators' ability to mitigate potential risks through regular use of exposure-reduction practices. The results indicate that safety educators can effectively deliver epidemiological research findings paired with clear risk reduction measures that applicators can adopt.

Keywords: agricultural health study, exposure, health, risk reduction, applicator, safety, behavioral change, Maryland, Washington, pesticide applicator training, PPE

Introduction

While many pesticides (insecticides, herbicides, fungicides, etc.) currently used in the United States pose little risk to human health, some have well-documented acute effects and/or have been associated with chronic effects (Blair et al.1985, Costa et al. 2008, Kamanyire and Karalliedde 2004, Morrison et al. 1992, Pearce and Reif 1990, Savage et al. 1988, Weichenthal et al. 2010).

The Agricultural Health Study (AHS) is an ongoing prospective investigation of agricultural exposures and health outcomes sponsored by the National Institutes of Health and the Environmental Protection Agency. AHS study data includes information on almost 90,000 pesticide applicators and their spouses in Iowa and North Carolina (Alavanja et al. 1996). The AHS study's goals include the identification of probable associations and possible causal relationships between certain exposures, including pesticide uses and/or application methods, and adverse health effects. Based on convergent evidence from repeated findings over the course of the study, AHS researchers have identified associations and possible causal relationships between certain pesticide uses and/or application methods and prostate cancer, retinal degeneration, and Parkinsonism (Alavanja et al. 2003, Kamel et al. 2006). Additional results from AHS, although preliminary, point to possible links between pesticide exposures and diabetes, colorectal cancer, depression, endocrine-mediated effects, and other outcomes (Beseler et al. 2006, Beseler et al. 2008, Farr et al. 2004, Farr et al. 2006, Lee et al. 2007, Montgomery et al. 2008, Saldana et al. 2007). The AHS researchers have not reached any conclusions as to whether these associations are

merely statistical or may be causative; they recognize further investigations are needed to address the nature of these relationships.

AHS researchers also investigated applicators' pesticide handling practices. They found that applicators that did not regularly practice certain safety measures had a greater chance of experiencing high pesticide exposure events (HPEE). These poor practices included not wearing gloves, delays in washing of their hands and bodies, delays in changing clothing after pesticide applications, laundering pesticide-contaminated clothing with the family wash, and storing pesticides in the home (Alavanja et al.1999).

AHS and other studies have documented pesticide residues in the homes of applicators and farmworkers (Curwin et al. 2002, Curwin et al. 2005, Simcox et al.1995). Residues inside the home environment could pose additional risks, particularly to sensitive individuals including children, the elderly, and persons with immune-compromised systems.

Some pesticide safety educators would like to share the results of carefully done epidemiological studies, like those of AHS, with the applicators they train. One of the earliest formal attempts to present such information was accomplished through the publication, *Understanding the Agricultural Health Study*, a series of three brochures targeting agricultural pesticide applicators (Storm et al. 2004a, Storm et al. 2004b, Storm et al. 2004c). The series was developed in collaboration with AHS researchers and presented an overview of the purpose and methodology as well as some of the findings from the first twelve years of the study. Storm also developed a PowerPoint® presentation and script that were shared with educators for their training programs.

Some educators and scientists have expressed concern that sharing the findings of epidemiological studies has the potential to mislead audiences since the study conditions may not closely replicate the experience of other applicators. Differences in terms of crops or sites, years working with pesticides, average number of days of pesticide use per season, type and method of pesticide(s) applied, and other factors could modify the outcomes of their exposures and practices. Thus, when results are presented to lay audiences other than the subjects in the actual study, little can be said about how the results of epidemiological studies might translate to audience members, even those who use the same pesticides. However, presenting the information has merit, but it requires guidance from the instructor regarding any potential risks and appropriate and feasible mitigation measures to avoid misleading the audience.

Applicators who assume that their actual risk resembles that of the study subjects may over- or underestimate the actual risk to themselves when in fact their risks may not be identifiable through current studies. They may also fail to understand there are actions they can take to reduce the likelihood of any potential risks. Together, these misunderstandings could create several undesirable results, including but not limited to:

- stopping the use of a particular pesticide or application method, which may be unwarranted and might adversely affect pest control, crop production, site protection, etc.;
- substituting a more toxic or potentially risky pesticide, which could lead to potential adverse effects on health and/or the environment;

- changing jobs altogether, which could affect income;
- increasing personal stress, which could affect the applicator's health and well-being; and
- loss of credibility of the presenter and/or the presenter's organization, which could affect future ability to provide effective outreach to the applicator audience.

Given the importance of sharing these findings with pesticide applicators and recognizing the aforementioned concerns about the message, the University of Maryland developed a training tool that tied the AHS research findings with an educational message on the benefits of minimizing occupational exposure to pesticides. Special care was taken to avoid misleading the audience about their own risk level and to frame the information in a way that would encourage adoption of best pesticide handling behaviors as a matter of everyday practice. Audience response system technology was incorporated into the presentation to assist in assessing the impact of the presentation on planned adoption of best practices. The training program was shared with Washington State University in 2009 and the Pesticide Safety Education Programs (PSEPs) in both states delivered the training during 2009 - 2011.

This paper describes a training method that incorporates epidemiological research findings into a general pesticide safety presentation to strengthen the message that applicators should use recommended handling practices. Secondarily, it presents data comparing the pre- and post-presentation (i.e., current practice and planned practice) pesticide handling practices of the applicators, which could spawn future research on any specific benefit(s) of delivering training that pairs epidemiological research results with a general safety message.

Methodology

In 2009, Dr. Amy Brown, University of Maryland Extension PSEP developed a PowerPoint presentation addressing the need for improved pesticide safety practices. The presentation, targeted to agricultural applicators, was titled "Pesticide Exposures and Applicators' Health: What We Know Now." The presentation included brief summaries of AHS findings of associations between pesticide exposures and adverse health outcomes. The research findings served as potential motivating factors for improved applicator safety practices. The presentation explained that AHS findings may not be directly transferable to the particular situation of an individual applicator, and that some of the AHS findings are preliminary. The presentation also included the AHS research findings on poor pesticide handling practices associated with increased risk of HPEE. The presentation emphasized that employing best practices at all times can be expected to decrease an applicator's risk of exposure and therefore should also reduce any potential health risks associated with exposure.

To enhance learning by engaging the audience, and to allow collection of impact data, the presentation incorporated audience response system technology (TurningPoint®, sometimes referred to as "clickers"). Use of this technology allows instantaneous collection of responses to demographic, evaluation, and impact questions at the time of presentation delivery. Audience response technology has been demonstrated to be an effective tool for teaching when used in traditional teaching settings such as university courses (Crouch et al. 2007, Preszler et al. 2007, Sharma et al. 2005, and Stuart et al.

2004). The tool has not been broadly tested with Extension audiences, but is beginning to be adopted and used in PSEPs and other Extension programs around the US. Anecdotal experience of the trainers involved in this project indicates that Extension audiences are often reluctant to answer questions in a public setting, especially when surrounded by others in their own field. The anonymous nature of clicker responses is likely to increase participation as well as improve willingness to answer questions truthfully. Clicker technology in the Extension arena shows great promise for both enhancing learning and assessing impacts (Brown and Richards in prep).

The first part of the PowerPoint® presentation queried applicators to characterize their current safety practices. This was followed by a brief discussion of the AHS findings, described above, as a possible motivation to adopt improved PPE practices, if practices warranted improvement (see description of preferred practices under each table in Results and Discussion). The last part of the presentation posed questions paired to those in the beginning to characterize the applicators' intentions to adopt practical safety practices in the future. Applicators were able to view the responses to each query. Discussion stimulated through use of the clicker questions provided an opportunity for instructors to emphasize points shown to be of particular interest to the audience(s), as well as to address overcoming perceived barriers to use of recommended safety practices.

During 2009-2011, both Maryland and Washington Extension PSEPs conducted training sessions for several groups of pesticide applicators by using the presentation. Prior to using the presentation, the Washington trainers were coached by the Maryland trainer on how to deliver the message. The coaching focused on epidemiological methods, concepts behind statistical associations and cause-and-effect determinations, and avoidance of extrapolating identified risks from a research population to the present audience. Minor edits were made to the presentation to best suit the specific audience (agriculture, aerial, landscape).

Maryland and Washington PSEP coordinators collected the TurningPoint® data on current practices and planned adoption of improved practices. The Maryland group was comprised of 109 landscape contractors, lawn care operators and municipal employees attending a commercial applicator recertification session in January 2011. One Washington group included 530 municipal employees and lawn and landscape applicators who attended recertification trainings at six western Washington locations between December 2009 and March 2010. The other group trained by the Washington PSEP was comprised of 65 aerial applicators from Idaho, Oregon, and Washington attending the 2010 Pacific Northwest (PNW) Aerial Applicator Alliance annual meeting.

Some of the queries integrated into the presentation were more applicable to certain target audiences than to others. For example, respirator use was queried, but respirator use is only considered necessary when using some pesticides. Respirators are neither required nor desirable for many applicators in the target audiences. Therefore, the authors selected only two question pairs that queried behaviors considered to be best practices for all the applicators receiving the training. Data from these two-paired questions were tabulated to compare applicator responses from before and after the discussion on AHS research findings. The two questions selected as indicators included (1) use of gloves during application, and (2) showering after work.

Results and Discussion

Each set of two tables provided below compares the baseline data collected prior to the presentation with data collected after the presentation. Note that the number of respondents varies between tables within a comparison set and differs from the number trained because not all the attendees responded to all questions.

COMPARISON 1: Glove Use

TABLE 1a. Do you wear chemical-protective gloves when applying pesticides? (BASELINE)

	Maryland Lawn & Landscape Applicators (N=104)	WWA Lawn & Landscape Applicators (N=530)	PNW Aerial Applicators (N=63)
I wear gloves every time I apply any pesticide	49%	75%	43%
I only wear gloves to apply pesticides when the label requires them	30%	14%	19%
I wear gloves some of the time, depending on how much time I have, how hazardous I think the pesticide is, or some reason other than the label requires them	16%	6%	35%
I don't wear gloves to apply pesticides	5%	5%	3%

TABLE 1b. After hearing about the AHS research, will you wear protective gloves?

	Maryland Lawn & Landscape Applicators (N=109)	WWA Lawn & Landscape Applicators (N=509)	PNW Aerial Applicators (N=57)
I will wear gloves every time I apply any pesticide	77%	81%	77%
I will only wear gloves when the label requires them	14%	5%	9%
I will wear gloves some of the time, depending on how much time I have, how hazardous I think the pesticide is, or some reason other than the label requires them	6%	4%	14%
I won't wear gloves to apply pesticides	3%	10%	0%

For Maryland lawn and landscape applicators and PNW aerial applicators, preferred practice (wearing gloves every time plus wearing gloves when required by the label) was increased from 79% baseline to 91%, and 62% baseline to 86%, respectively, after hearing/seeing the research presentation. Even more importantly, the percentage of applicators using practices that may increase their risk of pesticide-related adverse effects (wearing gloves based on no particular logic plus not wearing gloves at all) decreased from 21% to 9% and from 38% to 14%.

For the western Washington applicators there was no real change (wearing gloves every time or wearing gloves when required by the label) between the baseline and post-presentation data for either the use of preferred safety practices or practices that could increase their risk of adverse effects. However, the baseline data indicated use of

preferred practices was already so high (89%) that there was little room for improvement in this group. The percentage of applicators reporting they "do not" / "do not plan to" wear gloves actually increased from 5% at baseline to 10% after hearing the presentation. This serves as a good example of when further discussion during a clicker-assisted presentation could be useful. It might have been instructive to have asked whether those predicting they would not wear gloves in the future would be willing to share their reasoning.

COMPARISON 2: Showering after Application

TABLE 2a. When you've been applying a pesticide, do you shower after work?

	Maryland Lawn & Landscape Applicators (N=103)	WWA Lawn & Landscape Applicators (N=528)	PNW Aerial Applicators (N=65)
Yes, before going home	4%	11%	0%
Yes, when I get home, but BEFORE greeting my family or sitting down	66%	60%	52%
Yes, when I get home, but AFTER greeting my family or sitting down	22%	12%	36%
No, I don't shower after work	8%	17%	12%

TABLE 2b. After hearing about the AHS research, will you shower after work?

	Maryland Lawn & Landscape Applicators (N=100)	WWA Lawn & Landscape Applicators (N=499)	PNW Aerial Applicators (N=53)
Yes, before going home	5%	11%	5%
Yes, when I get home, but BEFORE greeting my family or sitting down	90%	70%	72%
Yes, when I get home, but AFTER greeting my family or sitting down	3%	4%	19%
No, I won't shower after work	2%	15%	4%

A common barrier to decontamination and cleanup for many pesticide applicators is having access to a shower at work. Those practicing good hygiene by either showering at work or showering at home prior to greeting the family and prior to sitting down (and potentially transferring pesticide residues to the home environment) increased from 70% at baseline to 95% after the presentation for Maryland applicators, 71% to 81% for western Washington applicators, and 52% to 77% for PNW applicators. Only 5%, 19%, and 23%, respectively, planned to continue poor hygiene, compared to 30%, 29%, and 48% prior to the AHS discussion. The increase from 0% at baseline to 5% post-presentation in showering before leaving work in the PNW aerial applicator population is also notable.

In considering the data presented here, two points must be explained. First, during the Maryland presentation, showering was discussed as being more effective at removing residues than taking a bath. This discussion element may have influenced more Maryland applicators to indicate they would shower in the future. Second, aerial

applicators have a different risk profile compared with commercial landscape applicators because some do not mix and load product, but only fly the plane or helicopter. The authors did not ask if the applicators mixed and loaded their application equipment, which is a major factor for pesticide exposure, and this should be corrected in future presentations.

Conclusions

The presentation methodology demonstrated an effective way to pair epidemiological research findings of pesticide-related health risks (prostate cancer, retinal degeneration and Parkinsonism) in the specific applicator population studied with a generalized message to reduce potential risks for other applicators (i.e., applicators outside the study population) by minimizing exposure. By interspersing pre-evaluation queries prior to a presentation and delivering new information (i.e., discussion of research-based findings of risk in a specific population) to applicators followed by post-presentation queries, pesticide safety educators can successfully assess the planned behavior changes against the baseline data. The TurningPoint® results clearly show that trainers can effectively deliver research findings showing increased risks of developing illnesses and/or disabling conditions in a manner that positively influences the self-reported predicted practices of pesticide applicators. It also presents the case that applicators realize they can make changes such as the proper use of PPE and good hygiene practices to mitigate potential risks.

The preliminary data presented here demonstrate that the presentation motivated pesticide applicators to plan to improve personal safety practices. This is especially compelling since the instructors emphasized that results of the AHS should not be generalized to other groups. It appears these audiences took the advice of the instructors to consider the adverse health effects findings only as an indicator of the types of increased risk some applicators may incur, and to recognize they can reduce any potential risks through regular adoption of best pesticide handling practices and proper hygiene to reduce their own exposure.

Audience response findings indicate that pesticide safety educators can use positive motivators (research findings and a clear message of risk reduction) to emphasize the various benefits of practical pesticide safety measures and can anticipate improved adoption of best practices by trainees who do not already practice them. Because opportunities for occupational, dietary, and incidental exposure of applicators, their families, and the general public are reduced when proper pesticide practices are employed, education of applicators can be an effective means to reduce exposures and thus the potential risk to all of these populations.

The results presented here provide an indication that AHS findings may act as a motivator to induce adoption of better practices. However, the protocol did not specifically test this effect, and thus it is beyond the scope of this paper to determine whether the AHS results do, in fact, play a motivating role, or whether the increase in recommended practices from baseline to post-presentation was due to some other factor. However, these preliminary results are intriguing, and a study currently being conducted by one of the authors will explore this idea further.

The training methodology appears sound for program development and delivery, and UM PSEP is developing a set of presentations using this method for distribution to pesticide safety educators throughout North America.

Key components of the presentation described here will be maintained in the set to be developed through inclusion of a trainer's guide to ensure consistency of purpose and message. The set will include presentations specifically targeted toward (1) agronomic crop growers and applicators; (2) nursery/greenhouse growers and applicators; (3) structural pest control operators; (4) landscapers, lawn applicators, and rights-of-way applicators. In addition, the incorporation of the baseline and post-presentation question series will facilitate impact-reporting efforts, since it will allow different units to report on the same outcome indicators. This is particularly powerful for measuring similar impacts across state lines and across pest control disciplines. Availability of the set will be advertised through the listserv of the American Association of Pesticide Safety Educators (AAPSE) and other avenues. Proposed delivery date for the trainers' guide and the presentation targeting agronomic crop growers and applicators is winter 2012-2013.

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