

INVESTIGATION OF A NEW METHOD FOR MONITORING WORKER EXPOSURE TO PESTICIDES:

A non-technical project description

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Safety & Health Assessment & Research for Prevention Division
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SHARP
*Safety & Health Assessment &
Research for Prevention*

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I. THE SHARP RESEARCH DIVISION

In 1993, the Safety & Health Assessment & Research Division (SHARP) of the Washington State Department of Labor & Industries (L & I) began a study to examine the usefulness of a new method for monitoring agricultural worker exposure to pesticides. SHARP is a research program at L & I, formed in 1990 and independent of the Industrial Insurance Division (workers' compensation) and the Division of Industrial Safety & Health (WISHA). SHARP works cooperatively with employers and employees in a variety of industries, conducting projects related to prevention of workplace injury and illness. This report is a non-technical description of SHARP's first research effort in agriculture.

II. WHY DID SHARP DO THIS STUDY?

Monitoring workers for exposure to toxic chemicals such as pesticides can help ensure that workers are not having too much contact with harmful substances. Monitoring can help determine if any work practices or situations need to be modified to prevent health problems.

Washington State is an agricultural leader in the production of several labor intensive crops such as apples, pears, cherries, and hops. Thousands of agricultural workers are employed each year. Currently, traditional orchard crop production relies heavily on the use of insecticide types which are among the most toxic pesticides available for use.

In 1992, SHARP started working with a new, portable blood testing kit that measures cholinesterase. Cholinesterase is a normal substance in the blood and the nervous system. Many of the toxic pesticides of concern damage the nervous system by affecting this substance and making it less active (inhibited or lowered). (see table 1). Scientists have looked at lowering of cholinesterase as a measure of pesticide overexposure for many years. In California, cholinesterase monitoring for applicators, mixers and loaders has been required since 1974.

However, there have been difficulties with cholinesterase monitoring. The current practice relies on a worker going to a clinic or hospital to provide a blood sample. Usually, the blood is then sent to a laboratory for analysis. There are problems with the delay in time between a blood sample being collected, analyzed, and the worker and health care provider being informed of the results. Since each person's normal level of cholinesterase varies, it is important to know this level for comparison after exposure has occurred. In addition, different laboratories use different ways of testing cholinesterase and can not be compared. Finally, the cost of the testing may discourage its use.

SHARP was hopeful that this new kit could provide a more reliable, cheaper, and easier method for measuring blood cholinesterase. Therefore, in 1993 SHARP designed a study to bring the kit into several Washington orchards to test its usefulness for monitoring exposure to cholinesterase-inhibiting pesticides among agricultural workers.

III. HOW WERE WORKERS AND EMPLOYERS INVOLVED?

Agricultural workers who work with or around cholinesterase-inhibiting pesticides were recruited with the cooperation of their employers. Six growers assisted in this effort. All represented primarily apple orchard operations in Yakima or Benton-Franklin Counties. The sites ranged from very small, owner/operator run orchards to very large corporate farms employing hundreds of workers.

SHARP researchers visited the agricultural worker volunteers four times at their own or a convenient nearby worksite, once before spraying had begun and three additional times during the growing season. On each visit a fingerstick blood sample of a few drops was collected for immediate analysis using the testing kit. The first "pre-spray" measurement is known as the "baseline" or normal, unexposed measurement. Each individual's measurements made at later visits during the growing season were compared to their own "baseline" measurements made before

spraying began. Confidential written results and explanations were given to each participant during each visit. Worker's were advised in one of the three following ways, depending on their cholinesterase measurement:

- 😊 1. There is no problem.
(This meant that their cholinesterase measurement was not meaningfully lower compared to their own baseline.)
- 😐 2. There is a need to take caution.
(This meant that a possible problem with pesticide exposure was suggested because of somewhat lowered cholinesterase.)
- 😞 3. There is a need to take action and see a health care provider.
(This meant that the cholinesterase measurement was greatly lowered when compared to the baseline measurement. This may indicate too much exposure to cholinesterase-inhibiting insecticides. In these cases, a follow-up visit to a health care provider was recommended so that it could be looked into more completely.)

A brief questionnaire regarding pesticide exposure, health history and work history was administered to all participants during the second visit. During the third visit, blood was collected from both the vein and by the usual fingerstick method for comparison.

Growers were asked to provide records of pesticide application. Agricultural workers were given information on reducing exposure and at the end of the study all participants were awarded tinted safety glasses in appreciation for their involvement.

IV. WHAT DID SHARP FIND OUT IN THIS STUDY?

GROWERS AND WORKERS WERE VERY COOPERATIVE AND INTERESTED IN BEING INVOLVED IN THIS CHOLINESTERASE MONITORING STUDY.

95 agricultural workers volunteered to participate for baseline monitoring in March, 1993. Of these, approximately half (56%) were involved in pesticide spraying. About one third (38%) did not spray but worked in various field activities, such as thinning, pruning, and harvesting. A few (6%) worked at other activities, such as tractor maintenance, chemical inventory, pesticide mixing, etc. 69 (73%) of the agricultural workers who initially volunteered to participate were present for all four visits. 92% were available for at least three visits. The high level of interest and cooperative attitude encountered from all of the growers and workers involved in this study was impressive.

MEASURING CHOLINESTERASE WITH THE FIELD KIT IS EFFICIENT.

Measuring cholinesterase with the field kit is efficient. It took only five minutes for researchers to collect a fingerstick sample, analyze it, and provide results to each worker.

USE OF THE NEW FIELD KIT PRESENTED SOME TECHNICAL LIMITATIONS.

During the course of the monitoring activities, researchers discovered two main technical limitations with the new field kit.

Temperature limitations

The kit does not perform well at very cool temperatures. At one site where volunteer participants worked, the baseline cholinesterase measurements made in March, were done in a room that was much colder than normal room temperature (about 57° F or 14° C). This is because the room was not insulated from outside temperatures and it was a very cold day. These cholinesterase measurements were abnormally low, and differed greatly from all of the other workers who had

cholinesterase baseline measurements made at the same time but in warmer settings at more controlled temperatures (about 70° F or 21° C). These baselines measured in a cold environment were not considered accurate.

Manufacturing error

Between the time when the baseline monitoring was done and later visits, the manufacturer informed the researchers that the testing kits were fitted with a faulty component that over time could lead to inaccurate results. The kits were recalled and refitted with a replacement component. The researchers noted that the refitted testing kits did not yield the same results on non-exposed blood samples which were tested before and after the new component was added. This raised concern about the study design which would compare baseline measurements made on the original test kits with measurements made later on the refitted test kits. A correction factor for adjusting worker baselines was calculated so they could be used to directly compare cholinesterase measurements made later on the refitted test kits. This correction factor was based on comparing a group of non-exposed workers with blood cholinesterase measurements made before and after the test kits had been refitted with the new component.

FINGERSTICK BLOOD SAMPLES ARE NOT CONTAMINATED BY PESTICIDES ON THE HANDS.

During one of the visits, workers were requested to donate both a fingerstick blood sample and a sample drawn from the vein. This was done so that the cholinesterase measurement from the finger and vein could be compared. SHARP researchers wanted to determine if workers who work with or around pesticides have pesticides on their hands which would contaminate a blood sample taken from the finger. In this study, most participants were able to wash their hands prior to testing. In addition, all individuals had their finger cleaned with an alcohol swab before the sample was taken. It was found that measuring cholinesterase with a fingerstick sample of blood yielded the same results as the blood that was drawn from the vein. This suggested that the fingerstick samples were not compromised or contaminated due to pesticide residue on the hand.

THE FIELD KIT CAN IDENTIFY WORKERS WHO ARE RECEIVING TOO MUCH EXPOSURE TO PESTICIDES.

In the diagram below, observed changes from adjusted baseline cholinesterase measurements (visit 1) are summarized for agricultural workers who participated in visit 2, 3, and/or 4. The observed changes are arranged according to the same scheme as that described previously for informing participants of their results.

	visit 2	visit 3	visit 4
☺ AGRICULTURAL WORKER PARTICIPANTS			
No problem	74 (92%)	71 (93%)	69 (93%)
Cholinesterase inhibition			
☹ "Take caution" level	4 (5%)	1 (1%)	2 (3%)
☹ "Take action" level	2 (3%)	4 (5%)	3 (4%)
TOTAL	80	76	74

In summary, at each monitoring visit, 5 to 6 workers (7% - 8%) were identified as having significantly lowered cholinesterase levels when compared to their adjusted baseline cholinesterase levels. It was suspected that pesticide exposure accounted for these changes with the exception of two cases. In one case, the decrease in cholinesterase was felt to be due to the worker's concurrent use of a medication that also decreases cholinesterase. In another case, the worker's baseline measurement was unusually high and felt to be inaccurate for comparison. Of the remaining

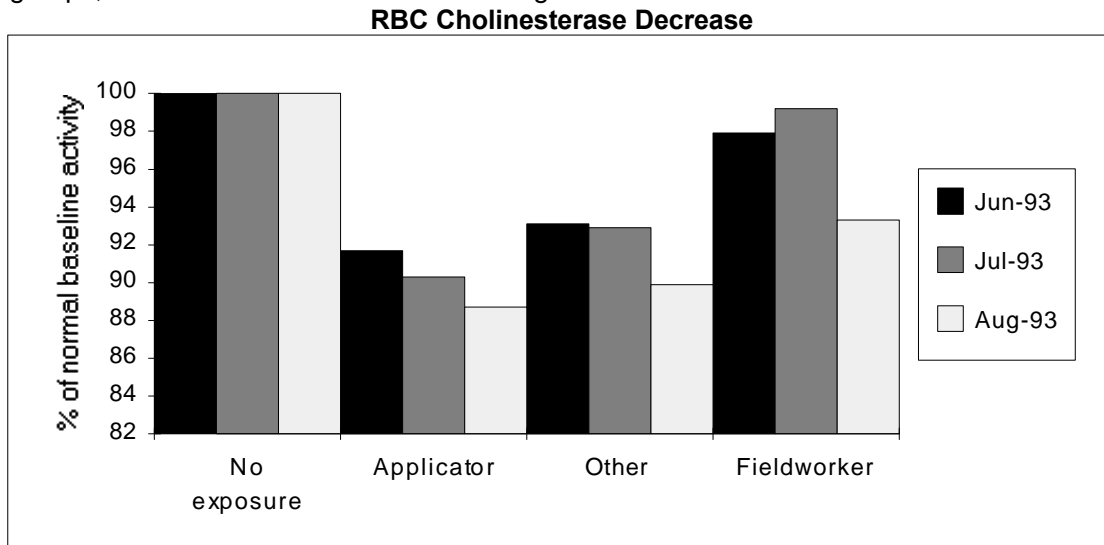
lowered cholinesterase, all were observed in workers who were involved in pesticide spraying except for one worker who loaded pesticides but did not do any spraying.

It must be kept in mind that these results depended upon adjusting worker's baselines as described above under "manufacturing error". The adjustment may or may not be reliable. SHARP researchers are looking at other ways to interpret these results.

A group of twelve workers in the poultry industry who do not use pesticides in their work was also monitored in exactly the same way. This group was used as a comparison group because they were similar to the agricultural worker volunteers in age and ethnic background. None of these workers were identified as having lowered cholinesterase.

CHOLINESTERASE LEVEL CHANGES THROUGH THE SEASON ARE DIFFERENT FOR WORKERS IN DIFFERENT EXPOSURE GROUPS.

The agricultural worker volunteer participants who completed all four cholinesterase measurements in the study were grouped according to their work activities. Different work activities are thought to represent different kinds of pesticide exposure. The applicator group included all agricultural workers who were involved in spraying pesticides. The fieldworker group included all agricultural workers who were involved in field activities such as thinning, pruning, and harvesting but did not do pesticide spraying. A small group of workers was grouped as "other". These workers did not do pesticide spraying but had contact with pesticide concentrate as pesticide mixers, pesticide loaders, spray machinery mechanics or cleaners, or chemical inventory personnel. The cholinesterase changes observed over the season for different exposure groups are compared in the diagram below. In this broad comparison of red blood cell cholinesterase, applicators changed (decreased) the most, followed by the group labelled "other", followed by fieldworkers. Also, in all three groups, red blood cell cholinesterase change increased over time.



V. WHAT DO THE FINDINGS OF THIS STUDY MEAN?

For the workers and growers that participated in this study, monitoring cholinesterase with a portable field kit appeared to be a welcome and beneficial approach to addressing concern about potential overexposure to cholinesterase-inhibiting pesticides.

The field kit employed in this study is a new technology that requires some modification to address some technical problems encountered in its use. Specifically, accurate measurement across a wide range of temperatures, such as may be encountered in worker monitoring programs, is important. Secondly, assurance of the dependability of the components is essential.

This study was designed to evaluate a new method for monitoring blood cholinesterase levels. The specific questions addressed include:

1. How feasible is this new method of cholinesterase monitoring among agricultural workers?
2. Does the new method identify problematic cholinesterase level changes in individuals with season long exposure to cholinesterase-inhibiting pesticides?
3. Based on measurement with this new method, is there a relative difference in cholinesterase level effects among different exposure groups?
4. Does pesticide residue on the hand contaminate and compromise cholinesterase measurement using a fingerstick sample?

While it is recognized that employees and employers have many additional questions related to pesticide exposure and potential health problems, it is important to point out that this study can shed light only on the points listed above. Further, more detailed analysis of the information collected in this study may offer additional insight into the points discussed. A technical report containing this analysis is due to be available in December 1993.

Table 1.

Examples of cholinesterase inhibiting pesticides used on orchards involved in this study

Azinphos methyl (Guthion)	mevinphos (Phosdrin)
Phosphamidon	ethion
Phosmet	carbaryl (Sevin)
Chlorpyrifos (Lorsban)	dimethoate (Cygon)
Parathion (Penncap)	trithion
mevinphos (Phosdrin)	