



# Cholinesterase Monitoring of Pesticide Handlers in Agriculture: 2007 Final Report

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**Division of Occupational Safety and Health (DOSH)**

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This report has been prepared by John Furman, DOSH Technical Services

## **Executive Summary**

This report summarizes the results of blood cholinesterase monitoring conducted in 2007 under chapter 296-307-148 WAC, Cholinesterase Monitoring. Previous reports provide detailed background and describe cholinesterase monitoring experiences during the years 2004 – 06.<sup>1</sup> Primary program changes in 2007 included the transition of laboratory services from the Washington State Public Health Laboratory (PHL) to Pathology Associates Medical Laboratories (PAML), and laboratory test data transfer directly to the Division of Occupational Safety and Health (DOSH). Laboratory service and data management systems are described in this report.

During the 2007 cholinesterase monitoring season (January 15 – October 4), 226 employers and 1857 pesticide handlers participated in baseline cholinesterase testing. Three hundred and sixty eight of these pesticide handlers were tested again (periodic testing) at least once during the application season. This assumes that the great majority of handlers submitting periodic tests met the testing requirement threshold of handling<sup>2</sup> toxicity class I and II organophosphate or N-methyl carbamate pesticides for  $\geq 30$  hours in any consecutive 30 day period.

Of these 368 handlers, 49 (12.6 %) received at least one test with a greater than 20% depression in cholinesterase activity (action level) requiring the employer to evaluate pesticide handling practices, and 18 (4.6%)<sup>3</sup> were temporarily removed from exposure to covered pesticides because of a red blood cell cholinesterase depression of  $\geq 30\%$ , or a serum cholinesterase depression of  $>40\%$  (see Table 3 for 2004 – 07 comparisons). The overall rate of handlers experiencing an action level cholinesterase depression, in the population receiving periodic testing, increased from 12.1% in 2006 to 17.3% in 2007. Taking into account the observed test variability in 2007, it is likely that over-exposures held even or declined in 2007 versus prior years. No handlers were identified, through occupational monitoring, with pesticide related symptoms

The number of handlers undergoing blood cholinesterase testing in 2007 was reduced by ~20% from the number in 2006. In addition, the number of participating employers continued its downward trend but appears to be leveling off. This is thought to reflect industry pesticide use patterns, employer experience in identifying pesticide handlers covered by the testing requirements of the rule, and employer actions resulting in limiting handler exposure (e.g., increased use of integrated pest management techniques). To the extent that this reduction removes workers with relatively less pesticide handling, it would be expected that the average exposure of the remaining group of handlers would increase if no other workplace changes occur.

All testing was conducted by Pathology Associates Medical Laboratories. PAML validated and instituted standard operating procedures for red blood cell and serum cholinesterase testing in the same manner as the PHL in 2004. Since cholinesterase analysis is highly variable between laboratories and methodologies it is difficult to compare results between laboratories and even within a laboratory from one year to another. However, a review of test and quality control data conducted by the University of Washington Department of Environmental and Occupational Health Sciences indicates red blood cell cholinesterase testing to be less precise than that achieved by the PHL in the previous years.<sup>4</sup> Wide precision range affects the accuracy of test

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<sup>1</sup> Cholinesterase Monitoring Scientific Advisory Committee and DOSH Reports to the Legislature can be found at [lni.wa.gov/Safety/Topics/AtoZ/Cholinesterase/default.asp](http://lni.wa.gov/Safety/Topics/AtoZ/Cholinesterase/default.asp)

<sup>2</sup> Pesticide handling includes the activities listed in the definition of “Handler” found in chapter 296-307-11005 WAC

<sup>3</sup> One handler experienced cholinesterase depressions to both the evaluation and removal levels. For purposes of this report this handler was assigned to have cholinesterase depression to the removal level.

<sup>4</sup> Letter to John Furman from David Kalman, Chair University of Washington Department of Occupational and Environmental Health Sciences, December 2, 2007. [lni.wa.gov/Safety/Topics/AtoZ/Cholinesterase/default.asp](http://lni.wa.gov/Safety/Topics/AtoZ/Cholinesterase/default.asp)

results in relation to action levels. In response, laboratory quality control parameters for 2008 have been amended to require a better than 10% precision.

The Cholinesterase Monitoring Data Management System (CMDS), an electronic data management system developed to integrate with the PHL's information technology structures, remained semi-active in 2007. Difficulties in integration outside of the DOH network prevented CMDS from receiving test data in real time and generating reports. This had no affect on communication of test results to health care providers, employers, and handlers. By the end of May DOSH Technical Services was able to receive test data directly from PAML. In 2008, data management will be centered in the DOSH Industrial Hygiene Laboratory with services commensurate with those provided by CMDS.

Twenty two employers had at least one employee with a cholinesterase depression to the action level. Nine of these employers accepted a DOSH consultation review of their pesticide worker protection program. While employers generally had competent worker protection programs a variety of potential exposure scenarios (e.g. wearing a hooded sweat shirt during airblast applications) and related Pesticide Worker Protection Standard violations (e.g. entering restricted entry areas without the use of personal protective equipment) were identified.

As in previous years, agriculture pesticide handlers with cholinesterase depression to the action level were generally employed in the tree fruit industry and involved in airblast pesticide application. All cholinesterase depressions to the action level occurred in L&I Region 5 (West Adams, Benton, Chelan, Columbia, Douglas, Franklin, Grant, Kittitas, Okanogan, Walla Walla, and Yakima counties). DOSH consultation evaluations found violations of the Pesticide Worker Protection Standard in areas that included, but were not limited to; respiratory protection, personal protective equipment, and decontamination. Toxicity class I and II cholinesterase inhibiting pesticides handled, or with otherwise potential exposure, prior to testing included Lorsban, Sevin, Imidan, Carzol, and Guthion.

DOSH conducted programmed inspections of nine employers who had previously participated in cholinesterase testing but were not participating in 2007. None of these employers were found to be in violation of cholinesterase testing requirements. One employer failed to provide training on the hazards associated with cholinesterase-inhibiting pesticides and the benefits of medical monitoring as required under chapter 296-307-14840 WAC. Employer actions to limit handler exposure included, but were not limited to; a) use of organic farming methods, b) use of integrated pest management technologies, c) employer application of pesticides, and d) handler rotation.

The 2007 cholinesterase monitoring experience was definitely one of transition. While challenges were presented we are in a position going forward to solidify laboratory services and surveillance systems for the foreseeable future. Examples of actions being taken include, but are not limited to; a) contracting for laboratory consultation services, b) working with health care providers to help ensure that handlers are informed of their test results, and c) updating WISHA Regional Directive (WRD) 33.27, Cholinesterase Depression,<sup>5</sup> to better define effective DOSH field service responsibilities. These and other actions will ensure effective application of the Cholinesterase Monitoring Rule as we move forward.

**If you have questions about this report please contact John Furman, DOSH Technical Services Hygiene Supervisor, at 360-902-5666 or [furk235@lni.wa.gov](mailto:furk235@lni.wa.gov)**

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<sup>5</sup> WRD 33.27, Cholinesterase Depression, December 2007. [lni.wa.gov/Safety/Rules/Policies/Topic/default.asp](http://lni.wa.gov/Safety/Rules/Policies/Topic/default.asp)

## **Background**

Cholinesterase (acetylcholinesterase) is an enzyme that removes the chemical neurotransmitter acetylcholine, from the junctions between nerves cells. By doing so, cholinesterase effectively serves as the nervous system's "off switch" and is essential to normal nervous system function. Certain pesticides, known as cholinesterase inhibitors, can adversely affect human cholinergic pathways.

Exposure to organophosphate or N-methyl-carbamate pesticides may lower the level of available cholinesterase in the nervous system. Depressed cholinesterase activity may lead to symptoms ranging from blurred vision, diarrhea, loss of balance, and tremors.

Monitoring cholinesterase levels in the blood (both serum and red blood cell cholinesterase) through simple laboratory tests can detect cholinesterase depression prior to the onset of related symptoms, as well as provide information regarding pesticide exposure and the effectiveness of exposure control measures.

WAC 296-307-148, Cholinesterase Monitoring (the rule), was adopted in December 2003 and remains unchanged since amendments were made in 2005. The rule requires agriculture employers to; a) record hours employees handle<sup>6</sup> toxicity class I and II organophosphate and N-methyl-carbamate pesticides, b) provide cholinesterase blood testing to employees who handle covered pesticides for 30 or more hours in any consecutive 30 day period, and c) follow health care provider recommendations regarding handler pesticide handling practices and medical evaluation.<sup>7</sup> A copy of the health care provider's written recommendation is provided to the handler by the employer. Health care provider recommendations include cholinesterase percent change from baseline, direction regarding actions to be taken based on cholinesterase activity, and any additional direction regarding further medical evaluation.

Detailed discussions of occupational cholinesterase monitoring and history of the rule can be found in the 2004 - 2006 Cholinesterase Monitoring Scientific Advisory Committee Reports to L&I, and the Washington State Cholinesterase Testing: Guidelines for Health Care Providers Manual ( <http://www.lni.wa.gov/Safety/Topics/AtoZ/Cholinesterase/default.asp> ).

In 2007 laboratory testing services transitioned from the Washington State Public Health Laboratory (PHL) to Pathology Associates Medical Laboratories, Spokane WA (PAML). The transition to a single commercial laboratory was agreed upon in 2005 as mandated priorities prevented the PHL from continuing to provide an essentially commercial service. With the assistance of the PHL, L&I selected Pathology Associates Medical Laboratories to provide laboratory testing services in 2007 and thereafter.

During the fall of 2006 PAML validated and instituted standard operating procedures for red blood cell and serum cholinesterase testing. Standard operating procedures for blood cholinesterase analysis were based on methodologies established by the PHL. Blood sample collection and laboratory testing procedures remained basically unchanged from 2005.<sup>8</sup> The only significant difference was that PAML provides laboratory courier services, allowing for prompt pick up and delivery of samples.

The laboratory transition process included migration of Cholinesterase Monitoring Data System (CMDS) functions from the Department of Health (DOH) to PAML and DOSH. These included; a) matching and coding of pesticide handlers and employers, b) calculating cholinesterase

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<sup>6</sup> Pesticide handling is defined in WAC 296-307-11005

<sup>7</sup> Employer action requirements are found in WAC 296-307-14825

<sup>8</sup> PAML, Collecting and Shipping Whole Blood and Serum Specimens for Cholinesterase. Available from DOSH upon request

activity change from baseline, c) flagging cholinesterase depressions >20% from baseline, d) maintaining and aggregate data base, and e) providing for secure transfer of information to DOSH.

While PAML began building these capabilities it was agreed that DOH would continue to support CMDS, and its active functions, within the Pesticide Illness and Monitoring Program. This support relied on the ability to successfully transfer data between PAML data systems and CMDS. Standardized reports could not be readily transferred to CMDS in real time and as a result individual pesticide handler test reports were provided directly to DOSH Technical services through PAML's secure server. CMDS continued to receive aggregate test reports from PAML.

The legislature has authorized expenditures of up to 3.2 million dollars from the L&I Accident Fund during the current biennium to cover the costs of laboratory testing, and to reimburse employers for other clinical and related administrative costs incurred. Employer reimbursement policies and protocols can be found at <http://www.lni.wa.gov/Safety/Topics/AtoZ/Cholinesterase/files/413062af.pdf> . Testing, data collection, and employer reimbursement costs for calendar year 2007 totaled ~\$111,595.00. Employer reimbursements will continue in 2008.

## **Laboratory program**

Under chapter 296-307-14815, Pathology Associates Medical Laboratories (PAML) has been approved as the sole laboratory providing cholinesterase testing services. The selection process included; a) solicitation of qualifications from clinical laboratories operating in Washington State, b) review of blood cholinesterase analysis standard operating procedures and data management systems, c) consideration of capacity and customer service systems, and d) PHL onsite evaluation of the top two rated laboratories.

PAML directly contacted all participating health care providers and established contracts. Many participating providers were already PAML clients so the transition from the PHL was relatively easy. Fifteen health care providers submitted pesticide handler samples in 2007. PAML bills health care providers directly for services at \$44.00/paired sample submission. Health care providers charge for services by billing employers for laboratory costs + service charges. In turn, employers have the opportunity to recoup test and program maintenance costs through DOSH reimbursement.

PAML referenced the PHL's Standard Operating Procedures for Red Blood Cell and Serum Cholinesterase Analysis in developing their Standard Operating Procedures.<sup>9</sup> Testing is performed on an automated instrument (the Olympus 5420 analyzer) similar to that used by the PHL and the Roche reagent used by the PHL is also being used by PAML. The goal was to stay as close to the PHL procedure as possible to assure similar results.

Validating the assay for cholinesterase went smoothly. Time was spent with both Roche and Olympus to make the necessary adjustments and create new parameters for the Olympus analyzer. The assay performed well for both red blood cell and serum test methodologies. Final validation was accomplished in December and baseline testing began January 15, 2007.

Both internal and external (blind sample submissions) quality control programs were utilized to monitor testing competency. Analysis of quality control data demonstrate analytical processes

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<sup>9</sup> PAML, Toxicology Procedure Manual, E7.1, Cholinesterase in Serum and Red Blood Cells. Available from DOSH upon request

that are under control. However, red blood cell quality control data showed more variability than serum. This was in part a consequence of using the manufacturer standard of +/-20% precision for the red blood cell control product used (Precinorm). Correlation improved through the testing period. A goal for 2008 is to improve precision of controls to <10% coefficient of variation (CV). To aid in accomplishing this PAML has enrolled in the College of American Pathologists serum cholinesterase proficiency testing program and will participate in red blood cell cholinesterase proficiency testing activities through Dr. Barry Wilson's Laboratory at UC Davis.

A review of test and quality control data conducted by David Kalman, PhD, and Gerald van Belle, PhD indicates red blood cell testing to be less precise than that achieved by the PHL in 2004-06. This analysis compares 2004 -06 data quality with 2007 test and quality control data (see Tables 1 and 2). It is important to bear in mind that absolute values for red blood cell and serum cholinesterase measures are not comparable between laboratories. However, patterns in cholinesterase depression ratios may be meaningfully compared over time.

The 2007 potential false positive rate (at >20% cholinesterase depression recognition level) for serum cholinesterase is estimated to be 1.21%. This demonstrates exceptional consistency and is comparable with rates achieved in 2005 (1.21%) and 2006(2.43%). Red blood cell cholinesterase results were more variable with a potential false positive rate of 14.6% (Table 2). This is much higher than the 2004 estimated rate of 3.98%. Dr. Kalman states that "...the rate of work practice alerts for red blood cell cholinesterase (depressions >20%<30%) could be as low as zero after correction for random variation. At the 30% depression level, this pattern is repeated. The overall finding for red blood cell cholinesterase is not qualitatively different than that seen in prior years, but the uncertainty is much larger."

Table 1: Precision for RBC and serum ChE results, 2004-2007

	RBC ChE				Serum ChE			
	2004	2005	2006	2007	2004	2005	2006	2007
<b>I. Replicate Precision: Blinded Field QC Samples</b>								
N pairs	53	186	*88	107	53	176	*89	107
% CV	6.5%	4.2%	3.8%	16.7%	1.6%	2.1%	2.5%	2.6%
dates/person	1 or 2	up to 7	*up to 5	up to 6	1 or 2	up to 7	*up to 5	up to 6
<b>II. Estimated Within-Person % CV from Monitoring Results</b> (baseline vs first periodic test)								
% CV	9%	5.5%	4.3%	15.1%	10%	6.6%	8.3%	7.1%

\*through 7/31/2006 only

Table 2 - Alerts and false positives, 2004-2007

RBC ChE depression	2004 results		2005 results		*2006 results		2007 results	
	>20% depression	>30%	>20% depression	>30%	>20% depression	>30%	>20% depression	>30%
False Positive Rate	3.98%	0.25%	0.43%	0.0013%	0.012%	0%	14.6%	4.63%
Number, periodic tests	911	911	954	954	*692	*692	510	510
Observed positives	47	15	21	1	4	0	67	20
Estimated maximum number of false positives	≤ 35.80	≤ 2.28	≤ 4.03	≤ 0.01	≤ 0.10	< 0.00	≤ 76.00	≤ 24.00
Adjusted rate of alerts**	1.3%	1.4%	≤ 1.8%	0.10%	0.6%	0%	< 0 **	< 0 **
Serum ChE depression	>20% depression	>40%	>20% depression	>40%	>20% depression	>40%	>20% depression	>40%
False Positive Rate	5.73%	0.02%	1.21%	0.00001%	2.43%	0.0003%	1.21%	0.00001%
Number, periodic tests	911	911	954	954	*692	*692	510	510
Observed positives	155	29	86	12	96	12	24	2
Estimated maximum number of false positives	≤ 31.32	≤ 0.03	≤ 10.63	0	≤ 15.2	0	≤ 10	0
Adjusted rate of alerts**	≤ 14%	≤ 3%	≤ 8%	negligible	11.9%	1.7%	2.80%	0.39%

\*through 7/31/2006 only

\*\* potential number of false positives exceeds the number of observed positives

As a result, interpretation of trends in the incidence of cholinesterase depression between 2006 and 2007 is complex. Taking all test results as correct, the modest increase noted in proportion of handlers showing alerts (12.1% to 17.3%) is the result of two offsetting effects: a 20-fold increase in RBC alerts and a 3-fold decrease in serum ChE alerts. However, the confidence in the serum result is high as there is no indication of major analytical uncertainty in that test, while confidence in the RBC result is much less since the test imprecision is such that random variation could account for all of the observed alerts. Weighing these uncertainties would support the conclusion that actual incidents of cholinesterase depression to the action level in 2007 were at or below 2006 levels.

A concern is bias introduced by poor sample integrity after collection, until arrival at the laboratory. It was felt that the time between collection and transport to the lab was so minimal that there would be very little influence on the sample however; blood conditions occasionally noted upon arrival to PAML (e.g. micro-clotting) beg a closer look at sample quality. Blood collection, storage, and transport areas of emphasis for 2008 include ensuring adequate sample volume, thorough mixing to prevent formation of micro-clots, and proper temperature maintenance.

Early in the testing season difficulties were identified with the use of hand held temperature meters and acceptance of specimens outside of the allowed temperature range (2-8°C). Both of these issues were corrected by mid season. Samples are now shipped with water vials to allow for accurate fluid temperature readings upon receipt. Adherence to sample acceptance and rejection protocols continues to be a priority. Couriers and laboratory processors will be provided education about correct sample handling protocols and will be required to document any samples that do not meet appropriate conditions.

DOSH has contracted with Dr. Barry Wilson to confer on laboratory methods and procedures. Dr. Wilson is a neurotoxicologist who has conducted extensive research on organophosphate pesticides and the standardization of blood cholinesterases to detect over-exposure. His work was one of the first to show that commercial FDA approved cholinesterase assay methods were not necessarily optimum for assaying blood. Recently the State of California changed its regulations to require that clinical laboratories use Dr. Wilson's conditions to optimize the assay or show an acceptable conversion between their assay and the optimum one. Dr. Wilson was also a member of the Washington State Cholinesterase Monitoring Scientific Advisory Committee and had involvement with developing testing services at the PHL.

Test turn around time was exemplary. PAML courier services provided sample same day pick up for all but the two health care providers located in Whatcom County which utilized overnight air. Average time from sample collection to testing was less than 24 hours with many tests run the same day. Average time from sample collection to result reports was <5 days. Results were reported to health care providers via fax or electronically. By mid-May DOSH had access to all individual test reports at the same time as the health care provider.

During the period of inactivity before baseline testing begins again in 2008 PAML is actively evaluating all aspects of testing services from making changes in the test requisition form layout to improve data capture, to making changes in test methodology in order to limit sources of variability. To this effect some changes to the analytical operating procedures may be made for 2008.<sup>10</sup> The goal is to achieve a level of precision at the 5-10% CV range. While this level of precision is more rigorous than that generally applied for clinical purposes, it is achievable with sustained effort.

## **Summary of the 2007 Cholinesterase Monitoring Experience**

As in the previous three years the vast majority of employers participating in the medical monitoring program had operations located in L&I Region 5 (West Adams, Benton, Chelan, Columbia, Douglas, Franklin, Grant, Kittitas, Okanogan, Walla Walla, and Yakima counties). L&I Regions 1 (Island, San Juan, Skagit, Snohomish, and Whatcom) and 4 (Clark, Cowlitz, Grays Harbor, Klickitat, Lewis, Mason, Pacific, Skamania, Thurston and Wahkiakum) accounted for the remainder of the samples submitted

During the 2007 cholinesterase testing season (January 15 – October 4), 226 employers participated in testing and 1857 employees submitted cholinesterase baseline tests. The number of handler samples submitted to the laboratory from January through July totaled 2389. From 2004 - 06 the total number of samples decreased 12-13% each year, presumably (at least in most cases) because of employer actions resulting in reduced exposure time, but also because employers became better at estimating exposure time. However 2007 total number of tests is close to the 2006 total of 2582, whether or not this is the beginning of a leveling out trend remains to be seen.

The rule allows employees to either choose to participate or decline participation in the employer's cholinesterase testing program. The option is consistent with other WISHA rules that contain medical surveillance provisions. As an additional protection against potential coercion regarding the handler's decision to participate in the program the rule includes the requirement that this decision is made in conversation with the health care provider. DOSH did

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<sup>10</sup> The PAML 2008 procedure for Analysis of Cholinesterase in Serum and red Blood Cells is available by request from DOSH.

not track the number of handler declinations in 2007, however there have been no cases of potential coercion identified.

Handler cholinesterase baseline measures are established each year prior to, or after not handling in the previous 30 days, organophosphate or N-methyl-carbamate pesticides. In certain circumstances (e.g. a new employee has recently handled organophosphate or N-methyl-carbamate pesticides for another employer) the rule does allow for baseline measures to be established after recent handling. In this case, the baseline test result is termed a “working baseline.” In 2007, 120 handlers (6.5%) submitted working baselines. This is a substantial increase from 48 in 2006. Establishment of a working baseline may result in the baseline being artificially depressed due to exposure. It is difficult to tell how many baselines are true “working baselines” or the result of misclassification by the employer or health care provider, as over half did not include reported handling hours. L&I and PAML will work with health care providers to ensure accurate test classification.

Of the 386 employees who received at least one periodic test, 49 employees (12.6% percent) received at least one periodic test result with a greater than 20 percent cholinesterase depression from baseline (action level), requiring the employer to evaluate pesticide handling practices for possible deficiencies. Of those same 386 employees, 18 (4.6%) were temporarily removed<sup>11</sup> from exposure due to a larger cholinesterase depression (at least 30 percent depression in red blood cell cholinesterase or 40 percent depression in serum cholinesterase). The 67 total handlers (4 of these handlers experienced cholinesterase depressions to the action level of both red blood cell and serum cholinesterase) who experienced cholinesterase depression to the action level in 2007 worked for 22 different employers. No handlers were identified, through occupational monitoring, with pesticide related symptoms.

As noted the in the laboratory program summary red blood cell cholinesterase test confidence was low compared to previous years. Variability in red blood cell test results was noted early on in the season resulting in increased clinical scrutiny. Circumstances such as clusters of red blood cell cholinesterase depressions or red blood cell cholinesterase depressions occurring in handlers who had not recently handled cholinesterase-inhibiting pesticides prompted immediate retesting of those handlers. Of the 31 handlers retested 22 demonstrated red blood cell cholinesterase levels within 20% of baseline or exceeding baseline measures resulting in the original red blood cell cholinesterase depressions as being classified as non-depressions. In this context a non-depression is defined as a single red blood cholinesterase depression to the action level with immediate retesting of the handler demonstrating cholinesterase activity within 20% of baseline and attending health care provider agreement that the depression was likely a non-depression. In all cases the employer was notified of the original depression and appropriate handler protections were provided during the evaluation period.

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<sup>11</sup> Employees may return to handling covered pesticides when cholinesterase levels return to within 20% of baseline. While medically removed from exposure to covered pesticides employee pay, seniority and other benefits are maintained at the pesticide handler level for a maximum of 3 months.

	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
Employers participating in testing	380	316	244	226
handlers submitting baseline tests	2630	2263	1889	1857**
Handlers with at least 1 periodic test	580	611	471	386
Periodic tests	911	970	692	532
Handlers with ChE depression to work evaluation level	97 (16.7%)	49 (8.0%)	50 (10.6%)	49(12.6%)
Handlers with ChE depression to exposure removal level	22 (3.8%)	10 (1.6%)	7 (1.5%)	18(4.6%)*
Total # handlers with ChE depression	119(20.5%)	59(9.6%)	57(12.1%)	67(17.3%)

*\*Since cholinesterase analysis is highly variable between laboratories and methodologies it is difficult to compare results between laboratories and even within a laboratory from one year to another.*

*\*\*120 handlers submitted “working baselines” this is an increase from 48 in 2006.*

*\*\*\*One handler experienced simultaneous ChE depressions to both the evaluation and removal levels.*

<b>Month</b>	<b>Samples Tested</b>	<b>Periodic tests</b>	<b>RBC depressions handlers*</b>		<b>Serum depressions handlers*</b>	
			<b>&gt;20%</b>	<b>≥30%</b>	<b>&gt;20%</b>	<b>≥40%</b>
January	12	0	0	0	0	0
February	539	1	0	0	0	0
March	1048	22	0	1	2	0
April	385	228	18	4	8	2
May	210	124	4	8	6	1
June	63	45	2	0	3	0
July	89	74	11	2	1	0
August	36	32	0	0	0	0
September	7	6	0	0	0	0
October	0	0	0	0	0	0
<b>Total</b>	<b>2389</b>	<b>532</b>	<b>35</b>	<b>15</b>	<b>20</b>	<b>3</b>

*\* 2 handlers experienced simultaneous red blood cell and serum ChE depression, 2 handlers experienced an initial ChE depression to the evaluation level then ChE depression to the removal level at next testing, and 2 handlers experienced an initial ChE depression a normal result at next testing then a second ChE depression at subsequent testing. In total 67 handlers experienced at least 1 cholinesterase depression to the action level.*

## **L&I Consultation and Compliance Activities**

WISHA Regional Directive 33.27, Cholinesterase Depression (July 2006),<sup>12</sup> outlines consultation and enforcement policy. When a handler experienced a cholinesterase depression to the action level the employer would be contacted by DOSH and offered consultation services. Compliance referrals would be made under the following circumstances:

- The employer declines the offer of consultation services for a second time.
- An employer has received at least 2 consultations as a result of cholinesterase depressions but continues to have additional employees with cholinesterase depression to the action level.
- Consultation identifies circumstances that warrant a compliance referral, e.g. hazards are not abated in a timely manner.
- DOSH Technical Services identifies trends or circumstances that indicate employer safety program deficiencies, e.g. cholinesterase depression clusters or ongoing employee cholinesterase depressions.

The cholinesterase monitoring field consultations were performed by two consultation specialists assigned to provide cholinesterase monitoring and agriculture related services. DOSH consultants collected surveillance information using a standard series of questions (see WRD 33.27). The questions included worker name, birth date, primary language and number of years as a handler. The employer name was recorded along with additional information regarding the number of acres, crop types, the types of ChE inhibiting pesticides handled, pesticide handling activities, use of personal protective equipment (PPE), and identification of the potential cause(s) of exposure. Employers who received consultation services are required to correct any serious job safety and health hazards or deficiencies found.

Nine of the 22 employers (17 had one or more employees with cholinesterase depression to the action level in previous years) who had employees with cholinesterase depression to the action level accepted consultation visits. Average number of days between referral to regional staff to site visit was 12 days. Upon contacting one employer it was found that the handler, although enrolled in the employer's program, was not tested under the employer's cholinesterase monitoring program. The handler had sustained an exposure to Demeton while cleaning up a spill in a storage shed. The handler sought medical evaluation through a local emergency room and the blood sample was sent to PAML for analysis. The DOH Pesticide Illness office is evaluating this case.

No employers received compliance visits under the parameters outlined in WRD 33.27. However, DOSH did conduct programmed compliance inspections of another nine employers who had previously participated in cholinesterase testing but were not participating in 2007. None of these employers were found to be in violation of rule testing requirements.

### **Consultation visit summary**

As in previous years, agriculture pesticide handlers with cholinesterase depression to the action level were generally employed in the tree fruit industry and involved in airblast pesticide application. Growing operations were located in L&I Region 5 (West Adams, Benton, Chelan, Columbia, Douglas, Franklin, Grant, Kittitas, Okanogan, Walla Walla and Yakima counties). Respirator program, personal protective equipment, decontamination, and restricted entry interval violations were commonly cited during consultations evaluations. Toxicity class I and II cholinesterase inhibiting pesticides most frequently handled prior to testing include Lorsban, Sevin, Imidan, and Guthion.

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<sup>12</sup> Available on request from DOSH.

The following summarizes each of the consultation evaluations:

1. **Crop:** Apples and Cherries  
**Acres:** 4,008  
**ChE depression:** Handler A: 24% RBC; Handler B: 20% RBC; Handler C: 69% Serum  
**Handling hours:** Not reported  
**Handler duties:** Application, equipment decontamination  
**PPE:** North Full Face respirator, Rain suite, chemical resistant gloves.  
**Application method and equipment:** Airblast  
**Pesticides handled:** Lorsban  
**Potential exposure:** hooded sweater worn by handler, inconsistent decontamination  
**Rule violations:**
  - Mixing and Loading site was found to lack an emergency shower.
  - One gallon eyewash reservoir installed at mixing and loading site was non compliant.
  
2. **Crop:** Apples  
**Acres:** 21.5  
**ChE depression:** Handler A: 31% RBC  
**Handling hours in 30 days prior to testing:** 51.3 hours  
**Handler duties:** Thinning and Application  
**PPE:** None  
**Application method:** NA  
**Pesticides handled:** Lorsban  
**Potential exposure:** Entering area under REI  
**Rule violations:**
  - The employer did not provide notification of areas treated as required
  
3. **Crop:** Apples  
**Acres:** Not given  
**ChE depression:** 41% RBC  
**Handling hours in 30 days prior to testing:** 40  
**Handler duties:** Application  
**PPE:** Moldex half-mask respirator, rain suite, chemical resistant gloves  
**Application method:** Airblast  
**Pesticides handled:** Lorsban, Sevin  
**Potential exposure:** Inadequate respiratory protection, lack of formalized safety programs  
**Rule violations:**
  - No written Accident prevention Program
  - No written Chemical Hazard Communication program
  - No written Respiratory Protection Program
  - No respirator fit testing
  - Organophosphate and N-methyl-carbamate handling hours not documented

4. **Crop:** Fruit Trees

**Acres:** Not reported

**ChE depression:** Handler A: 24% Serum; Handler B: 22% Serum and a subsequent 22% RBC

**Handling hours in 30 days prior to testing:** Handler A: 39 hours; Handler B: 67 hours prior to serum ChE depression, 16 hours prior to RBC depression

**Handler duties:** Application, equipment decontamination

**PPE:** North Respirators, KASCO helmet respirator, rain suite, chemical resistant gloves

**Application method:** Airblast

**Pesticides handled:** Sevin, Lorsban, Guthion, Imidan, Carzol

**Potential exposure:** Inadequate respiratory protection

**Rule violations:**

- Emergency flushing equipment not provided
- Respirator fit testing not done in previous 12 months
- No record of work practice evaluations required under WAC 296-307-148
- No respirator cartridge change-out schedule
- Inadequate PPE maintenance
- Inadequate respirator maintenance

5. **Crop:** Apples

**Acres:** 265

**ChE depression:** 47% RBC

**Handling hours 30 days prior to testing:** Not reported

**Handler duties:** Application, equipment decontamination

**PPE:** North half-mask, rain suite, chemical resistant gloves

**Application method and equipment:** Airblast

**Pesticides handled:** Lorsban, Guthion, Imidan, and Sevin

**Potential exposure:** Inadequate decontamination

**Rule violations:**

- The respirator program did not contain a cartridge change-out schedule
- PPE was not utilized during equipment decontamination

6. **Crop:** Apples and Cherries

**Acres:** 512

**ChE Depression:** Handler A: 24% Serum; Handler B: 26% Serum; Handler C: 47% RBC

**Handling Hours 30 days prior to testing:** Not reported

**Handler duties:** Application, equipment decontamination

**PPE:** North model: 7700-30M half mask respirator, rain suite, chemical resistant gloves

**Application method and equipment:** Airblast

**Pesticides handled:** Lorsban

**Potential exposure:** Expired respirator cartridges.

**Rule violations:**

- The respirator program did not contain a cartridge change-out schedule
- A clean area for decontamination away from pesticide storage or use areas was not provided

7. **Crop:** Cherries, pears, grapes, and apples  
**Acres:** 380  
**ChE depression:** Handler A: 25% Serum  
**Handling Hours 30 days prior to testing:** 61.5  
**Handler duties:** Application, equipment decontamination  
**PPE:** North full face mask respirator, rain suite, chemical resistant gloves  
**Application method:** Airblast  
**Pesticides handled:** Lorsban  
**Potential exposure:** Skin exposure during airblast application  
**Rule violations:**
  - Soap and towels were not provided for handler decontamination
  - Hand washing facilities were not provided
  - Respirators were not decontaminated between use and stored on open counters
  - Pesticide application records were not stored in at a central location in the workplace and were not readily accessible to employees
  - Material Data Safety Sheets were not stored in at a central location in the workplace and were not readily accessible to employees
  
8. **Crop:** Apples, grapes  
**Acres:** 900 apples, 200 grapes, 25 cherries  
**ChE depression:** Handler A: 21% RBC; Handler B: 28% RBC and a subsequent 32% RBC  
**Handling hours 30 days prior to testing:** Handler A: 23 hours; Handler B: 50 hours prior to initial depression, 30 hours prior to subsequent depression.  
**Handler duties:** Application, equipment decontamination  
**PPE:** North full face mask respirator, Rain suite, chemical resistant gloves  
**Application method:** Airblast  
**Pesticides handled:** Lorsban, Guthion, Imidan  
**Potential exposure:** No PPE worn while decontaminating equipment  
**Rule violations:**
  - The respirator program did not contain a cartridge change-out schedule
  
9. **Crop:** Apple  
**Acres:** Not given  
**ChE depression:** Handler A: 32% Handler B: Serum; 21% RBC  
**Handling hours 30 days prior to testing:** Handler A: 35.3; Handler B: 34.1  
**Handler duties of employees:** application, equipment decontamination  
**PPE:** half mask respirator, rain suite, chemical resistant gloves  
**Application method:** Airblast  
**Pesticides handled:** Lorsban  
**Potential exposure:** Exposed to contaminated PPE  
**Rule violations:**
  - Detergent was not used to decontaminate PPE.
  - The respirator program did not contain a cartridge change-out schedule

### **Compliance summary**

DOSH conducted programmed compliance inspections of nine randomly selected employers who had previously participated in cholinesterase testing but were not participating in 2007. The primary focus was to determine compliance with the Cholinesterase Monitoring Rule and discover what changes occurred that reduced handler exposure hours to below threshold. None of the employers had a handler who exceeded the 30 hour/month handling threshold requiring referral for cholinesterase testing. In one instance an employer who continued to use Guthion had not been provided required training on the health hazards of cholinesterase inhibiting pesticides and the purpose of medical monitoring. No other violation of the Cholinesterase Monitoring Rule was found.

All inspected worksites maintained tree fruit orchard blocks with one employer also growing hops. Class I and II cholinesterase-inhibiting pesticides (Guthion, Sevin, Imidan, Lorsban) continued to be used however in smaller quantities than in previous years. Actions taken resulting in reduced handler exposure included a) rotation of handlers to maintain handling hours below 30/month, b) owner application of pesticides, c) increased use of integrated pest management, and d) increased use of organic farming methods.

Related violations of agriculture standards found included:

- No respirator cartridge change-out schedule
- Emergency washing facilities not provided at pesticide mixing station
- No written respirator program
- Respirator users not provided medical evaluations
- Respirator users not provided fit testing
- Pesticide handling records not maintained
- Inadequate pesticide hazard training
- No written chemical hazard communication program
- Material safety data sheets not maintained at worksite

### **Conclusion**

The 2007 cholinesterase monitoring experience was definitely one of transition. Blood cholinesterase testing participation continues to be leveling off as is expected through rule maturation and pesticide utilization affects. Total number of handlers with cholinesterase depressions to the action level (67) was not out of line with that identified in 2005 (59) and 2006 (57). While red blood cell cholinesterase precision was closer to that achieved in 2004, this was not unexpected given the complexities of red blood cell cholinesterase analysis and the start up nature of the PAML program.

All laboratory testing procedures are currently being evaluated to identify and limit potential areas of bias. Dr. Barry Wilson's laboratory and the DOSH Industrial Hygiene Laboratory are adding support to this process. This along with increase quality control oversight is expected to result in much tighter laboratory precision.

The DOSH Industrial Hygiene Laboratory will be receiving standardized test reports from PAML on a daily basis and notifying DOSH Technical Services of any cholinesterase depression >20% from a handler's baseline. WISHA regional Directive 33.27, Cholinesterase Depression, is being updated to clarify the communication chain between DOSH Technical Services and Regional Field offices. This will ensure that all employers who have an employee with a cholinesterase depression to the action level are contacted by DOSH and receive a field visit within a timely manner.

DOSH would like to thank all of those involved in supporting ongoing implementation of the Washington State Cholinesterase Monitoring Rule, especially; Pathology Associates Medical Laboratories, Department of Health, Department of Agriculture, University of Washington Department of Environmental and Occupational Health Sciences, Dr. Barry Wilson, and all of the participating health care providers. Whose help has greatly contributed to the success of the program and places us in a favorable position to move forward.