The Effects of Aerial Spraying with *Bacillus thuringiensis Kurstaki* on Area Residents.

by
Marty Pearce, MPH[1*], Gordon Behie, BA, **Neena Chappell**, PhD[2]
Capital Health Region, 2-2631 Quadra Street, Victoria, BC Canada V8T 4E2

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ABSTRACT

Study Objective

To determine if the aerially applied pesticide, Foray 48 B, resulted in changes in self-reported mental and physical health effects.

Design

A randomly selected population (1009 individuals) was interviewed pre and post spray utilizing a symptom survey and a health status survey tool called the Short Form 12 Health Status Profile (SF-12) provided by Medical Outcomes Trust.

Setting

The activities occurred in the community of Victoria, British Columbia Canada on Southern Vancouver Island.

Participants

Adults living in the community.

Results

Analysis of symptom reporting showed no significant differences in symptom reporting following the aerial spray application either when comparing pre and post spraying timeframes or whether location of residence inside or outside the spray zone. Based on the SF-12, there were no significant changes in physical health scores and a small improvement in the average mental health score post spray for residents both inside and outside spray zone.

Conclusions

Our population survey suggests that aerial exposure to Btk-based insecticides does not result in measurable acute health effects in the general population.

Key Words: Foray 48 B; SF-12; health surveillance and aerial pesticide spraying

INTRODUCTION

Bacillus thuringiensis var kurstaki (BtK) has rarely been the subject of population-based studies intended to assess for human health effects attributed to aerial application of biological insecticides. Surveillance for human health impacts was conducted during aerial sprays in the United States (Washington and Oregon States), Canada (BC) and New Zealand [1-5]. Methods used consisted largely of: passive surveillance with laboratory follow-up of Bacillus isolates submitted to diagnostic laboratories, evaluation of hospital admissions and/or physician visits, collection of public self-reports of adverse effects and monitoring specific of exposed groups.

[1] Capital Health Region, Victoria, BC

[2] University Victoria, Centre on Aging

* Correspondence and Reprint Requests: 2-2631 Quadra Street, Victoria, BC Canada V8T 4E2, e-mail: **marty.pearce@caphealth.org**, telephone (250)-388-9019, fax: (250)-388-9273.

No study has reported on possible adverse health outcomes for the general population during aerial spray programs. Yet aerial spray programs continue to generate community concern as evidenced by the active opposition lobbying that has occurred in British Columbia prior to each spraying event. The general survey reported here was one component of a comprehensive surveillance system established to monitor human health during an aerial spray program in the Victoria, BC Canada area during the spring of 1999.[6-9]

The objective of this study was to track changes in human health outcomes that may be temporally associated with aerial application of a Btk containing biological pesticide (Foray 48B Abbott Laboratories) and its components. The human health outcomes monitored included mental and physical health status as well as self-reported symptoms.

METHODS

Telephone interviews were conducted before and after the first spray date on a randomly selected sample of adults (age 18 and over) residing in the Capital Health Region (CHR). The initial sample was selected from the residential telephone listings in the CHR. All interviewing was conducted from a central telephone facility using Computer Assisted Telephone Interviewing (CATI).

The respondents were asked questions regarding their mental and physical health status, about any physical symptoms they experienced, and their attitudes towards the aerial spray program in general. Additional demographic information as well as geographic information was also collected.

Mental and physical health status was measured using the Short Form -12 (SF-12)[10] health status survey provided by Medical Outcomes Trust. The SF-12 is a short form, generic measure. The SF-12 measures eight concepts commonly represented in surveys: physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality (energy/ fatigue), social functioning, role limitations due to emotional problems, and mental health (psychological distress and psychological well being).

In 14 validity tests[11] of the SF-12 involving physical criteria, relative validity estimates for the 12-item Physical Component Summary (PCS) ranged from 0.43 to 0.93 (median=0.67) in comparison with the best 36-item short-form scale. Relative validity estimates for the 12-item Mental Component Summary (MCS) in 6 tests involving mental criteria ranged from 0.60 to 107 (median=0.97) in relation to the best 36-item short-form scale.

The questionnaire was pre-tested on a random sample of area residents prior to implementation. Bivariate analysis was performed on symptom variables. Statistically significant variables were then subjected to logistic regression to develop a model for each symptom. Comparison of mean MCS and PCS summaries was conducted for the SF-12 component. All statistical analysis was performed using SPSS for Windows Version 7.5.

Weather conditions during the spring of 1999, as recorded by Environment Canada at Victoria International Airport, were wetter and cooler than normal during April. This forced the spray operations to begin later than usual. The average May temperature was only slightly lower than normal (10.7 C compared to 11.4 C) with 108% of the normal hours of sunshine. Precipitation for the month of May was below average.

RESULTS

Telephone pre-spray interviews were conducted between April 30 and May 5, 2001. The post spray interviews were completed between May 10 and May 13, 2001. The first spray period for the program was May 8 and May 9, 2001. A total of 2127 telephone numbers were originally called to get an initial sample size of 1250 residents for a refusal rate of 39%. There were 1009 people who completed both the pre and post spray interviews. Of these there were 522 in the spray zone and 487 living outside of the spray zone. Table one shows a comparison of the in and out of the spray zone groups. Respondents living in the spray zone were more likely to be current smokers than respondents living outside the spray zone.

The prevalence of various symptoms reported by respondents in the pre and post surveys are shown in table 2. There were no differences in symptom reporting between the two groups at baseline. There were no significant increases in symptom reporting following the first spray period for either of the groups. The prevalence of "other symptoms" showed a significant decrease from 11.1% prior to the first spray to 4.6% after the spray for those respondents in the spray zone. For those living outside of the spray zone there was a significant decrease in "unexplained tiredness" from 14.8% to 10.1%.

Bivariate analyses were performed on each of the seventeen symptoms by respondents' attitude towards the spray for the entire sample. Of these 17 symptoms, seven were not statistically significant at the bivariate level. The remaining ten symptoms are shown in Table 3. The percentages of those respondents who are strongly opposed to the spray are compared to those persons who are strongly supportive of

the spray program. Looking at those respondents who reported redness or burning of the eyes, those strongly opposed to the spray (33.5%) are twice as likely to report this condition than those persons strongly supportive of the spray (15.5%). Furthermore, those strongly opposed to the spray are more likely to report a symptom than those persons strongly supportive of the program.

A logistic regression was used to create a model for each symptom. Having a certain symptom after the aerial spray, such as a headache, is used as the dependent variable. Table 4 provides information about all the independent variables used in each model.

Table 5 presents the results of the regression analysis. The greatest likelihood of having any of the ten post-spray symptoms is the fact respondents had the symptom in the pre-spray time period. Also, the number of pre-spray conditions increases the likelihood of having any of these post-spray symptoms. The likelihood of having post-spray redness of the eyes or post-spray diarrhea had only two significant factors: having the pre-spray symptom and number of post-spray symptoms.

Being inside the spray zone is not a significant factor in explaining the likelihood of any of these post-spray symptoms. Also, level of support for the spray is not significant for any of the models. Furthermore, there is only one post-spray symptom associated with opposition to the spray: difficulty sleeping. Those respondents who opposed the spray were slightly more likely to report this symptom.

Age and gender are significant in some of the models. Women are more likely to report post-spray headaches and unexplained tiredness than men. Older persons are less likely to report chapped lips, nausea, feeling tense and change in appetite. However, they are more likely to report a runny or stuffy nose.

Results of the SF-12 mental component scale (MCS12) and physical component scale (PCS12) are shown in table 6. Residents surveyed inside the spray zone as well as those outside the spray zone showed a significant improvement in the mental component scale following the first spray period. There were no significant changes in the physical component scale for either of the two groups.

SF-12 scores were examined by age group and income level for those respondents inside and outside of the spray zone. There are no significant decreases from the pre-spray period to the post-spray period in either the mental or physical scale for any of the subgroups. However, those respondents with lower levels of income report lower scores on the physical scale at pre-spray time. Those households with household incomes of less than $30,000 score lower on the average physical score: 47.33 compared to an average score of 50.63 for those with annual household incomes between $30,000 and $59,999 ($t=3.30$, $p<.001$) and an average score of 51.35 for those respondents with households incomes $60,000 or more ($t=4.27$, $p<.001$). These differences hold in the post-spray time period. There are no differences in SF-12 mental average scores across levels of income. Also, there are no statistically significant gender differences on either the average mental score or the average physical score.

DISCUSSION

The Capital Health Region (CHR) was ordered by the Provincial Government to conduct a health surveillance program during the 1999 aerial spray program to control an infestation of North American Gypsy moths in the Victoria Region. The surveillance program was implemented partially as a response to a 1998 BC Environmental Appeal Board ruling which prevented a planned eradication program in Greater Victoria.[12]

No differences in reported symptoms between those inside and outside the spray zone or before and after the spraying were conducted were found. For those living inside the spray zone, there was no change in reported symptoms after the spray except for an improvement in the category "other." For those living outside the spray zone, there was an improvement in "unexplained tiredness" after the spraying occurred. There were no differences in other reported symptoms. Based on multivariate analysis, it was seen that the best predictor for the presence of specific symptoms post-spray was if a person reported the same symptoms in the pre-spray interview. Living inside the spray zone was not a predictor for any of the self-reported symptoms. Based on the standardized measure of health status, there was a small improvement in the average mental health score after the spray period for residents inside and outside the spray zone. There were no significant changes in the physical health scores.

One possible explanation for the improvements in mental health score in the community was the improved weather conditions that were needed for the program to proceed. The very wet spring of 1999 resulted in a delay in the spray program commencing. Conditions for spraying required a dry period with little wind. Changes in weather conditions have been linked with improvements in mental health status in other studies. Primarily the increased daylight period and warmer weather has been associated with improved attitudes and outlooks in people.[13, 14]

The focus of this component of the surveillance system was on short-term acute health effects. Long-term effects of exposure, cumulative effects of repeated or prolonged exposure, or the synergistic effects of exposure to spray components along with other environmental factors were not specifically studied. The presence or absence of temporal association of specific symptoms at the time of aerial spray application is insufficient to establish a causal relationship or prove the situation is safe. Many confounding factors, such as concurrent disease outbreaks or other environmental irritants, must be considered and controlled for in population studies.[4]

Other components of this project attempted to document potential human exposures.[7,8] There were significant increases in Btk in the human population after each aerial application, both inside and outside the spray zone. Btk was present in inhalable particle sizes for at least 9 days after aerial application outside of houses in the spray zone and for at least 6 hours inside houses in the spray zone.[7] This exposure extended beyond the boundaries of the spray zone in a gradient that could be related to wind speed and direction. Volunteers living inside and outside of the spray zone yielded Btk from nasal swabs. However, environmental studies also demonstrated the presence of Btk in people and the environment prior to spraying. These results demonstrated the limitations of using place of residence and/or time relative to the spray program as the primary means for categorizing human exposure to Btk. The main evidence against bias due to geographically - based classification is that there was no evidence of increased burden of illness after the spray in either of the groups.

The weight of evidence would suggest that aerial exposure to Btk-based insecticides does not result in measurable acute health effects in the general population. Future surveillance should explore the health effects in high exposure groups and should focus on medium- to long-term effects as well as the impacts of repeated exposure rather than making surveillance of acute effects in the general population a priority.

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