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Educational and Behavioral Interventions to Reduce Isocyanate Exposure in Auto Body Shops

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EDUCATIONAL AND BEHAVIORAL INTERVENTIONS TO REDUCE ISOCYANATE EXPOSURE IN AUTO BODY SHOPS

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Isocyanates are a major cause of occupational asthma. To reduce worker exposure to isocyanates, we conducted a prospective field intervention study of educational and behavioral feedback interventions. 14 auto body shops were randomly assigned to control and intervention groups; 103 workers from these shops consented to study participation. Original surveys of exposure-related Knowledge and Attitudes and Self-Reported Behavior were administered and behaviors were observed at baseline, 6, and 12 months. The intervention group participated in the full intervention with behavioral feedback continued throughout the first 6 months; the control group had no formal interventions until, at 6 months, they received educational training alone. In both study groups, knowledge and attitudes related to personal protective equipment and safe work practices improved substantially. Most improvements were sustained at12 months. The difference in improvement between interventions was borderline significant (p=0.056), indicating that behavioral feedback could be superior to educational training alone for improving knowledge and attitude scores. For self-reported behavior, greater improvement in the intervention group was not significant (p=0.15). At baseline, Self-Reported Behavior score was significantly correlated with Knowledge and Attitudes score and Hispanic ethnicity (p=0.008, and p=0.014), but not with job title, group assignment (intervention vs. control), age, or smoking status. Examining correlations at all study periods, group assignment and Knowledge and Attitudes score were both significant variables affecting self-reported behavior, raising the possibility of greater effectiveness of intervention with behavioral feedback. In conclusion, a multi-faceted intervention including educational training and behavioral feedback improves observed and self-reported safety behavior and related knowledge and attitudes in auto body workers exposed to isocyanates. The addition of behavioral feedback generated improvement in overall knowledge and attitudes that was borderline significant. Scores on the Knowledge and Attitudes Survey were significantly correlated with self-reported behavior, giving this survey great potential for use in characterizing auto body worker exposure risk and readiness for behavior change.

Acknowledgements

I am deeply grateful to my thesis advisors, Carrie Redlich and Meredith Stowe. Dr. Redlich provided mentorship and encouragement far beyond the subject matter of this research. Dr. Stowe guided me through the very earliest stages of asking questions to ensuring that this project was completed, despite my dedicated maneuverings in the opposite direction. I thank Shaoli Wang for his major contribution to the statistical analysis of this study and for his willingness to entertain frequent questions and untimely requests, and thank Mark Cullen for reviewing this work and introducing me to the Occupational and Environmental Medicine Program.

My husband and family have been vital sources of wellbeing, inspiration, and reminders to complete this work. My family lost a close friend, William Perl, to an asthma attack. It is my hope that this work contributes in some small way to preventing such tragedies.

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Introduction

Between 9-15% of all adult asthma cases in industrialized countries are attributable to work exposures [1, 2]. Among the most important contributors to occupational asthma, isocyanates are the leading cause of immune-mediated, occupational asthma in industrialized countries and a major cause of occupational asthma worldwide [2, 3]. Decreasing worker exposure to isocyanates is therefore an important strategy to reduce the sizeable burden of disease, disability, and economic loss due to occupational asthma.

Isocyanate Asthma

Isocyanates are a leading cause of occupational asthma. A group of reactive chemicals containing the functional group N=C=O (NCO), they are extensively used as a cross-linker in the production of polyurethane foams, coatings, and adhesives. The major commercial isocyanates, methylene diphenyl diisocyanate (MDI), toluene diisocyanate (TDI), and hexamethylene diisocyanate (HDI) all cause asthma. Rapid expansion of the polyurethane industry has increased the number of workers at risk for exposure to these isocyanates [4, 5]. Concern has also been raised about the potential relationship between isocyanates in consumer products and non-occupational asthma, particularly in children [6].

Occupational Exposure to Isocyanates

Because inhalation has been considered the primary route of isocyanate exposure, efforts to understand and minimize exposure have focused almost exclusively on this airborne route. Inhalation exposures have been reduced through respiratory protective equipment, improved engineering controls, and use of less volatile forms of isocyanates [7]. Surveillance has also been a focus of prevention efforts [8]. Despite this, isocyanates remain a leading cause of occupational asthma [4, 9]. Further, many of the work settings in which isocyanates are used give rise to significant possibilities for exposure to isocyanates by way of direct contact with the skin. Multiple lines of evidence suggest skin contact as an important route for sensitization [10]. Several skin and surface decontamination products, different types of gloves, and coveralls can be used to protect skin and have been shown to have varying degrees of effectiveness, as studied by our group [11]. Therefore, interventions to protect workers should target both inhalation and skin exposure.

Isocyanate Exposure in Auto Body Shops

The automotive refinishing industry is a common setting of occupational exposure to isocyanates, and one of the most common settings for isocyanate asthma [10]. There have been limited studies of interventions to prevent isocyanate exposure [7, 12] and none that we are aware of in auto body shops. Auto body shops present particular challenges to design of workplace interventions to prevent isocyanate exposure. Prior research by our group has characterized isocyanate exposures in auto body shop work and found that tasks required vary greatly from car to car, among workers in the same shop, and between shops [13]. Many opportunities for airborne and skin exposure were found during common tasks including spray application of primer, sealer, and clear-coat, preparation and mixing of coats, wet and dry sanding, and spray-gun cleaning [13]. Studies of substitution to prevent sensitization to latex gloves constitute the largest evidence base of primary prevention studies for an occupational cause of asthma [14]. However, substitution is not currently feasible in the auto body industry. Composed largely of small, family-owned businesses, shops in the industry have few resources to invest in comprehensive safety programs and engineering controls.

Effectiveness of Occupational Health Interventions

Seeking out causes of occupational illness and risk factors for injury or disease have been the traditional focal points of occupational health research. There has been much less systematic study of occupational health interventions [15, 16]. When interventions to increase worker safety and prevent harmful exposures are carried out, it is often without evaluation of the program's effectiveness [17]. A recent systematic review identified 148 occupational health intervention studies; most focused on musculoskeletal problems and injuries [15]. Three main approaches have been used to reduce exposures: engineering, administrative, and behavioral [17].

A 2006 review of the relative effectiveness of worker safety and health training methods, found that the most successful interventions were those with the greatest worker engagement [18]. Within the past 15 years, behavior-based safety approaches have increasingly been found to be effective in a range of occupational settings: industrial workplaces, farm work, mining, healthcare, and research institutions [19-25]. They have most successfully been used in reducing workplace injuries and accidents [26, 27], with fewer studies applied to interventions to reduce chemical exposures.

Behavior Based Safety

The behavior based safety approach is a collaborative, proactive method for identifying safe and at-risk behavior and setting goals to reduce occupational risks [26]. Avoiding punitive consequences for at-risk behavior, behavior based safety (BBS) seeks to increase worker empowerment and cultivate teamwork; it often begins with a group of workers defining target behaviors to be increased or decreased. This is followed by examination of circumstances or conditions in the workplace that must be altered to decrease risk and then action to change these conditions (e.g. identifying more comfortable forms of personal protective equipment to increase

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use of the equipment). To promote increased safe behavior and decreased at-risk behavior, BBS interventions often involve behavior observations by peers or supervisors with feedback that is designed to encourage safe behavior and highlight opportunities to decrease risk [26].

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Behavior based safety is, on an organizational level, very parallel to Motivational Interviewing in counseling and clinical medicine. Within the behavior based safety model, different types of behavior benefit from different types of intervention, e.g. behaviors can be unknowingly at-risk, knowingly at-risk, knowingly safe, or automatic. An instructional intervention with education sessions and directive feedback can help transition behavior from unknowingly at-risk to knowingly safe. Supportive intervention (practice) helps to move behavior from other-directed or self-directed to automatic or habitual (fluent). Finally, motivational interventions are best targeted to knowingly-at risk behavior, as they increase the positive consequences of a safe behavior.

Occupational Health Interventions Relevant to Prevention of Auto Body Isocyanate Exposure

Distributed across a wide range of occupational settings there are several studies of participatory interventions consistent with the behavior-based safety model that can inform efforts to prevent dermal isocyanate exposure in auto body shops. In a study of workers with sun exposure in Israel, repeated intervention and provision ofpersonal protective equipment were associated with increased sun protection and skin cancer awareness [28]. A comprehensive intervention that included educational training and management and worker involvement in safety initiatives to prevent skin conditions in Danish cheese dairies was effective in reducing eczema symptoms and increasing glove and moisturizer use [20]. In a study of workers participating in a hazardous waste worker training program to promote worker action to improve health and safety conditions, perceived management support was found to have a key role in maximizing the

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impact of training [29]. A study of a safety intervention in which Swedish farmers met repeatedly over many months to receive information or analyze farm safety incidents and accidents in groups found that farmers significantly increased safety activity, and had reduced stress and risk acceptance, although risk perception and perceived risk manageability were not changed. The most useful elements of the intervention were thought to include social interaction, long time period of the intervention, and incident analysis vs. just receiving information [30]. In a cross sectional study of motor vehicle repair garages, workplaces with systematic health, environment, and safety activities were positively and significantly correlated with improved physical working environment, social support, health-related support, and workers' participation in activities related to occupational health; workers at garages with systematic health, environment, and safety programs reported fewer musculoskeletal symptoms [31].

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In sum, successful elements in safety interventions for protection from dermal exposures, and in small businesses, are likely to include: a range of systematic activities (e.g. training, feedback, engineering controls, and/or discussion), active learning, provision of personal protective equipment, repetition, promotion of worker involvement, successful engagement of management support, and/or promotion of social interaction.

Behavioral Determinants of Worker Exposure

Improved understanding of underlying behavioral determinants of worker exposure is likely to be helpful in targeting safety interventions. A 2007 study by Geer et al. attempted to understand determinants of worker dermal exposure [32]. They examined knowledge, attitudes, and perceptions of workplace dermal hazards as recorded on a survey used a validated semi-quantitative method incorporating both observed behavior and self-report (DREAM) to evaluate these workers’ exposure in diverse industrial workplaces. They found no statistically significant associations between their overall Knowledge, Attitudes, and Perceptions survey scores and the DREAM measure of dermal exposure. However, they did find significant negative association between precautionary behavior and either high perceived-barriers to use of personal protective equipment or being in the age group 40-49 years [32]. There were marginally positive associations between protective behavior and two variables: worker self-efficacy with respect to personal protective equipment use, and the group workers with10-20 years of experience. In a different study, an evaluation of a bilingual pesticide education program that effectively increased farm workers' pesticide knowledge and two (out of four) behavior outcomes, workers with external health locus of control were less likely to adopt safety behaviors [21].

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To our knowledge, there have been no studies of behavior based safety interventions to reduce worker exposure to isocyanates in auto body shops, a common setting of occupational asthma. Challenges to such interventions include widely varied work tasks, the many opportunities for airborne and skin exposure, the small, family-owned nature of the industry, and few resources for investment in comprehensive safety programs and engineering controls. To evaluate intervention strategies to minimize isocyanate exposure in auto body shops, our group developed a multi-faceted educational and behavioral feedback intervention to promote use of appropriate skin and respiratory-protective equipment and other exposure-diminishing behaviors. These initiatives were guided by focus groups and extensive input from workers and management. Administrative and engineering controls were attempted simultaneously via coordination with management. To identify the most successful elements of the intervention, we sought to weigh the importance of behavioral feedback and to gain insight into the knowledge and attitude correlates of improved PPE use and safe behavior.

Purpose

To evaluate the effectiveness of an educational training and behavioral feedback intervention to promote safe work practices and use of personal protective equipment designed to reduce exposure of auto body shop workers to isocyanates.

Specific Aims

A. Assess the effects of a combined educational and behavioral feedback intervention on worker knowledge and attitudes.

B. Examine the effects of a combined educational and behavioral feedback intervention on worker self-reported behavior.

C. Determine whether our Knowledge and Attitudes Survey is a useful predictor of self-reported behavior, controlling for other worker characteristics.

C1. At baseline, determine correlation between various worker characteristics, Knowledge and Attitudes scores, and self-reported behavior.

C2. Determine effect of behavioral intervention on self-reported behavior outcomes.

Methods

Study Enrollment

Between 2002 and 2006, the Yale Occupational and Environmental Medicine Program conducted a prospective field intervention study, Safe Methods for Auto body Shop Health (SMASH) to examine the effectiveness of educational and behavioral feedback interventions on use of personal protective equipment (PPE) and improved safety behavior in Connecticut auto body shop workers with exposure to isocyanates.

14 auto body shops and 103 auto body shop workers were recruited. Workers in these shops had varying degrees of inhalation and skin exposures to isocyanates. Shops with similar background (operation size, yearly revenue, daily number of repaired cars, type of spray booths, type of paint used and type of personal protection equipment used, etc.) were selected from a target body shop population in Middlesex County, CT, and randomly assigned to two groups: the intervention group and the control group. All workers (including office workers) from the selected shops were invited to participate in the study, but the focus of recruitment was on workers with the highest potential for exposure to isocyanates, the painters, and technicians doing painting-related work such as sanding and priming.

All study participants were informed of the potential risks and benefits of study participation and signed informed consent documents. This study was approved by the Yale Human Investigation Committee. All study shops were also visited monthly to provide PPE supplies and maintain contact with study participants. The intervention consisted of several parts: engineering control, administrative interventions, respirator fit testing, educational training, and behavioral interventions. The educational training and behavioral interventions are the focus of this study.

Interventions and Group Assignment

The intervention group received the full range of intervention programs after baseline measurement. Effects of the intervention in this group were further assessed immediately after intervention (at the beginning of the study period) and again at 6 months. To assess the duration of intervention effect, participants in the intervention group were again surveyed at 12 months. In the intervention group, the behavioral feedback portion of the intervention continued throughout the first 6 months. Educational training was done only once, at the beginning of study participation except as described below for new workers. (See Appendix A for a diagram of the study design.)

The control group received none of these interventions in the first 6 months, and then received most (but not all) of the intervention programs at 6 months. (See Appendix A for a diagram of the study design.) The controls at no point received the behavioral feedback portion of the intervention.

Intervention Components

1) *Engineering Controls*

During the study period, managers worked with investigators to try to identify process changes or engineering controls that would reduce the potential for worker exposure to isocyanates. Few shops were able implement new process changes or engineering controls due to cost.

2) *Administrative Interventions*

These are management initiatives that modify a worker's work process in order to reduce workplace health and safety hazards. Administrative interventions in the study included:

respiratory protection programs, regular surface and skin decontamination, nitrile glove use, and frequent glove and coverall changes (provision of PPE).

3) *Educational Training*

Educational training included four components: a) Training session with video, b) One-on-one discussions with workers, c) Intervention posters, and d) Health and Safety booklet on Respiratory Protection and Surface and Skin exposure reduction methods. These components are discussed in detail below.

a) Training session with video

The 30-minute educational training sessions were scheduled during the morning coffee break. Auto body worker health and safety were discussed, with a focus on health hazards of isocyanates and solvents used in auto body paints. Measures to reduce inhalation and skin exposures were explained; the appropriate use and fitting of respiratory protection were demonstrated; training on gloves, surface and skin decontamination was provided; and wipe sampling showing isocyanate contamination was performed. New employees were addressed by providing this very same comprehensive educational training program to new employees on their first day on the job in intervention shops. Spanish interpreters were available to translate for individual Spanish-speaking workers with limited English proficiency (LEP). Training sessions in Spanish were scheduled when multiple Spanish-speaking LEP workers were present at a shop.

b) One-on-one discussions with workers

Our study staff had one-on-one discussions with each worker while they were doing their work. The importance of reducing inhalation and skin exposures was emphasized and specific methods that workers could use to decrease exposure were discussed in the context of study participants' ongoing work. Qualitative wipe tests were used to demonstrate potential for skin exposure.

c) Intervention posters

Intervention posters were created and displayed in the intervention shops beginning on the training day. The posters included pictures of proper respirator use and wipes with positive color changes from surface and skin contamination and glove breakthrough.

d) Health and Safety booklet on Respiratory Protection and Surface and Skin exposure reduction methods.

A health and safety booklet was created. This booklet had information on respiratory protection and surface and skin exposure reduction methods, including manufacturers' catalogs of products that clean off isocyanates and other auto body shop chemicals. A copy was provided to each worker.

4) Behavior Observation and Behavioral Feedback

Behaviors examined in this study include appropriate use of PPE such as nitrile gloves, coveralls, booths for painting, skin and eye protection, proper respirator use, appropriate hand hygiene, safe sanding, and reading materials data safety sheets (MSDS). Industrial hygiene technicians, trained to achieve inter-observer agreement of 90% or more, performed standardized observations using behavior checklists of worker behavior in all shops (see

Appendix B). In intervention shops, the industrial hygiene technicians also provided feedback to workers based on these observations. Feedback was structured to include praise of current protective behaviors, information about potential improvements to a protective behavior related to one of the worker's current tasks, and encouragement to adopt this behavior. Study technicians visited the intervention shops monthly to observe the behaviors and discuss safety issues with workers and managers. Observations were likewise performed at control shops, but no feedback was provided to workers.

A final component of behavioral feedback was motivational graphs. These posters reported data on shop safety behavior on a monthly basis in an easily understandable format (stickers to quantify protective behaviors in the auto body shop). (See Appendix C.)

Assessment of Knowledge and Attitudes Related to Safety and PPE

We assessed changes in workers' knowledge of and attitudes towards use of personal protective equipment and safe work practices by means of a survey conducted four times during the study. Baseline assessment of knowledge and attitudes in both groups, were supplemented in the intervention group by an additional assessment immediately after implementing the educational training. All participants were followed up for the one-year study period, with measurements made again at 6 months and 12 months. In the control group, assessment of knowledge and attitudes was also performed at baseline, then immediately before and after training at 6 months (See Appendix A for diagram of study design). We assessed all workers' self-reported behavior three times during the study period: at baseline, 6 months, and 12 months.

At the end of each phase, auto body shop owners and workers who participated in the intervention were solicited for their judgment of the success or failure of this intervention program and suggestions for future interventions using a questionnaire. To explore the effects of the intervention on knowledge, attitudes and self-reported behavior, our group designed a written Knowledge and Attitudes Survey and a separate written Self-Reported Behavior Survey.

Knowledge and Attitudes Survey

A survey was designed for this study to explore worker knowledge of and attitudes towards hazards in auto body shops, methods for respiratory and skin protection, and safe work practices (See Appendix D for a copy of the survey). It was entitled Section A of the "Opinion Questionnaire" and was made up of 16 questions. Nine questions were included to assess attitudes related to safety behavior; these addressed: perceived barriers to use of PPE and adoption of protective behaviors (e.g. Question 1, "Wearing Gloves makes it more difficult for me to paint well"), worker's confidence in their ability to implement protective behaviors (e.g. Question 15, "I am not sure which respirator to use for which job"), and importance to the worker of the protective behavior (e.g. "Wearing a respirator is not important to my health"). 5 questions evaluated factual knowledge of protective equipment and safe work practices (e.g. Question 5, "Nitrile gloves give me better protection than latex gloves"). We used a simple scale from 1-5 (1-strongly disagree, 2-disagree, 3-undecided, 4-agree, 5-strongly agree). Answers on the knowledge questions were scored so that a higher number correlated with correct answers on factual questions; Answers on attitudes test were scored to assign high numbers to answers expressing high confidence, high importance, and/or perception of low barriers to safe behavior.

We calculated a mean combined knowledge and attitudes score with 14 of the survey questions, discarding two questions, Question 2 and Question 7. These were discarded because they had the potential for disparate interpretation by study participants and posed difficulty in scoring and interpretation (see Appendix D). We analyzed responses to all individual questions.

Self-Reported Behavior Survey

We used a 10-question survey to measure self-reported behavior, entitled Section B of the "Opinion Questionnaire". We used a simple scale from 1-5 (1-always, 2-almost always, 3-sometimes, 4-ocasionally, 5-never). Answers on self-reported behavior questions were scored so that a higher number correlated with higher frequency of the safety behavior in question (i.e. an answer of 1-always was scored as 5, an answer 5-never was scored as a 1). (See Appendix E.)

<u>Evaluation of the program with workers</u>

A short questionnaire was used to collect information on the perceived protection, effectiveness, comfort, ease of use and overall acceptance of respiratory and skin protection equipment and devices. Specific comments were collected. The questionnaire was administered to all participants. The evaluation questionnaire was administered three times during the study: once after the training in Phase I, once at the end of Phase II (6 months) and once at the end of Phase III (12 months). The first assessment was related to the training, initial experience with the intervention protocol, and evaluation of the PPE products. The second assessed their experience in the first 6 months of the intervention program. The last examined reasons for non-compliance and suggestions for future interventions in this industry. The control group was evaluated three times regarding the health and safety programs existing in their shops. These data will be reported elsewhere.

<u>Data Analysis and Statistics</u>

Data was entered into Excel spreadsheets and transferred to SAS (Statistical Analysis Software) files. Liza Goldman Huertas and Meredith Stowe, PhD performed hand editing and logical checking before data analysis began. Liza Goldman Huertas prepared demographic data and used Excel to create graphs of survey responses.

With guidance from Dr. Stowe and Dr. Redlich, Liza identified priority questions and analyses and collaborated with Dr. Wang, a biostatistician in the program. Repeated measures analysis was used to examine the relationships between control shop and intervention shop workers over the course of the intervention study. Linear model regression was used to evaluate demographic variables and Knowledge and Attitudes scores as correlates of Self-Reported Behavior scores at baseline and comparing the interventions in the two groups. The correlation between Self-Reported-Behavior and Observed Behavior was calculated.

Additional Study Components

In addition to the study components mentioned above, concurrent activities in this study also included sampling participant isocyanate inhalation and skin exposure, and conducting urinary biological monitoring and spirometry with study participants. These analyses are ongoing.

Results

Demographics

103 workers from 14 auto body shops were enrolled in the study. All were male. Most of the workers in the study (58%) were technicians, with painters (33%) the second largest group, and office workers making up a small fraction of study participants (see Table 1).

Table 1: Characteristics of Control and Intervention Groups

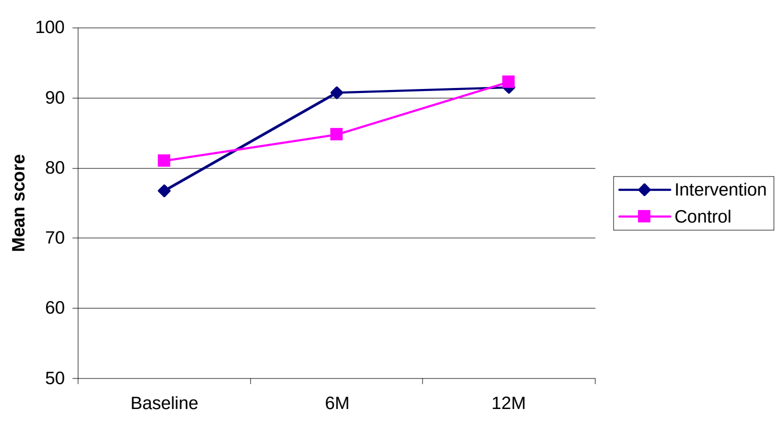
Characteristic	**All Workers**	**Workers in Control Shops**	**Workers in Intervention Shops**
Age	36 SD+/- 13	39.36 SD+/- 13.7	33.2 SD+/- 11.7
Job Title			
Office Worker	8.7% (9)	12% (6)	5.7% (3)
Painter	33% (34)	28% (14)	37.7% (20)
Technician	58.3% (60)	60% (30)	57.7% (30)
Hispanic Ethnicity			
Hispanic	15.5% (16)	16% (8)	15.1% (8)
Puerto Rico	5.8% (6)	8% (4)	3.8% (2)
Latino/Hispanic	3.9 % (4)	---	7.5% (4)
Ecuador	1.9% (2)	2% (1)	1.9% (1)
Guatemala	0.97% (1)	---	1.9% (1)
Uruguay	0.97% (1)	2% (1)	---
Cuba	0.97% (1)	2% (1)	---
Native American	0.97% (1)	2% (1)	---
Race			
White	83.5% (86)	84% (42)	83% (44)
Native American	0.97% (1)	2% (1)	---
White /Native American	0.97% (1)	---	2% (1)
Hispanic, Latino, or Nationality specified as Race	14.6% (15)	14% (7)	15.1% (8)
Smoking	33% (34)	32% (16)	34.6% (18)
Totals	n=103	n=50	n=53

Office workers were demographically distinct from other worker participants in that 100% were White and their mean age was greater (45.4). Technicians had a lower mean age, 37.7, and the highest percentage of Hispanics (23.3%). Painters, with the lowest mean age (31), were 91.2% White. The three groups had similar rates of smoking, with painters having the highest percentage of smokers at 35.3%.

There were no statistically significant differences in demographics between control and intervention groups. Trends were as follows: the control group was made up of older workers on average, had more office workers, and slightly more technicians, slightly more white workers, and slightly less smokers. Again, none of these trends were significant.

Knowledge and Attitudes Combined Mean Score

Figure 1: Knowledge and Attitude Score



The scores above (Figure 1) represent mean total scores of 14 of the Knowledge and Attitudes Survey questions. Two of the original questions, Question 2 and Question 7 were not included in the calculation of the combined score because both were found to be confusing and open to disparate interpretation.

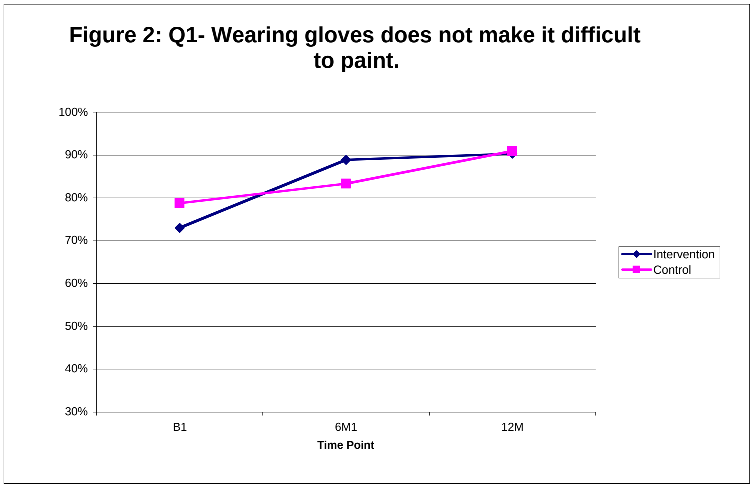
At baseline, mean scores in the intervention and control groups were similarly high with no significant difference (p=0.24), although the control group's mean Knowledge and Attitudes score was higher at baseline. The intervention group improved their combined Knowledge and Attitudes score by greater than 15% from 76.8, before intervention to 90.8 at 6 months. Thereafter, the mean combined Knowledge and Attitudes score in the intervention group remained about the same at 91.5.

In the control group, the mean combined Knowledge and Attitudes score also increased from baseline to 6 months. An increase in the mean combined score from 81.1 to 84.8 occurred in the control group without formal study intervention (no educational training or behavioral feedback). Despite this slight increase in the combined knowledge and attitude scores in the control group, the intervention group's scores increased significantly more than the control group's scores (p=0.002).

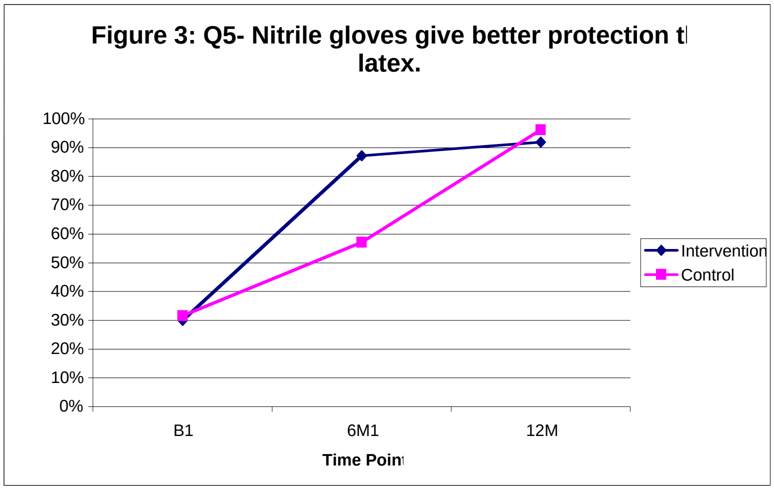
A larger increase in the Knowledge and Attitudes score in the control group occurred after intervention in that group, between 6 and 12 months, from 84.8 to 92.3. Comparison of intervention effectiveness (increase in Knowledge and Attitudes score between baseline and six months in the intervention group, and between 6 months and 12 months in the control group) shows a greater improvement in the intervention group. However this greater increase in the intervention group (the group receiving all portions of the intervention, including behavioral feedback) did not reach statistical significance (p=0.056).

Individual Knowledge and Attitudes Questions

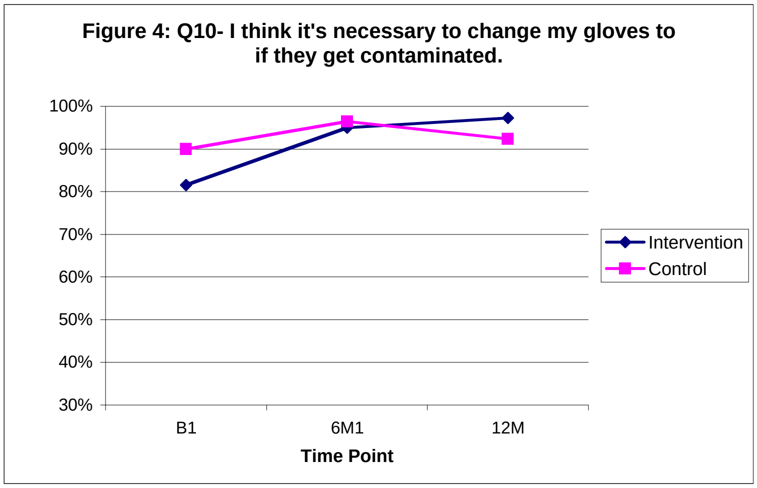
Among the 14 questions used for the combined Knowledge and Attitudes score, 4 questions showed statistically significant differences between control and intervention groups. Question 1 ("Wearing gloves does not make it difficult to paint") is representative (see Figure 2).



As was the case in 11 of the 14 questions used to arrive at our Knowledge and Attitudes scores, at baseline, the percent agreeing with protective attitudes and factual information about safety in the control group was slightly higher. However, this difference was not statistically significant in Question 1 (p=0.08) or in any of the other 14 questions (p values ranged from 0.06 to 1). Although the control group began with a higher percentage agreeing with the protective attitude, by 6 months, there was a significant rise in proportion of workers agreeing that gloves do not make their work more difficult in the intervention group. The difference in scores between control and intervention groups was statistically significant (p= 0.02). This increase in percent agreeing was sustained at 12 months. Echoing trends in the overall knowledge score, a small increase in percentage of workers agreeing with the safety-positive statement occurred in the control group between baseline and 6 months when these workers were not receiving the formal intervention, but were having their workplaces visited by industrial hygiene technicians. The increase in percent agreeing with safety-positive statement in the control group from 6 months to 12 months was smaller than the increase that occurred in the intervention group.

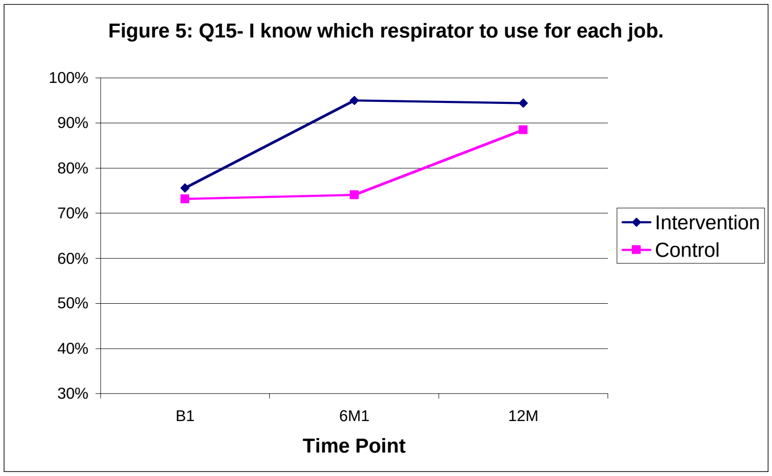


Two of the other questions with statistically significant differences between control and intervention groups at 6 months, Questions 5 and 10, also had glove-use as their focus. Question 5 is a knowledge question ("Nitrile gloves give better protection than latex). Intervention and control groups were essentially the same at baseline in percent correctly identifying nitrile gloves as providing greater protection than latex gloves, with the control group having an insignificantly higher percentage (p=0.18). Between baseline and 6 months, the percent of workers agreeing with this statement increased a great deal, without formal intervention. However, the increase in percent agreeing in the intervention group between baseline and 6 months was much greater than the increase in the percent agreeing in the control group between baseline and 6 months ($p<0.009$), and 6 months to 12 months (see Figure 3).



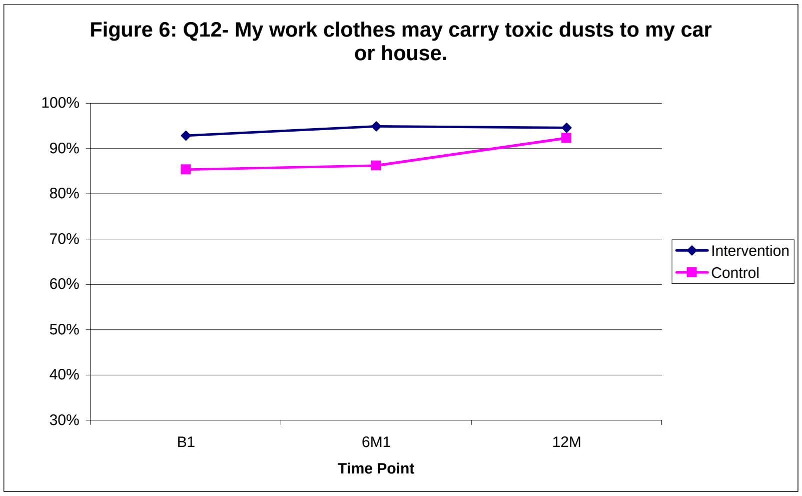
Question 10, also a knowledge question about gloves, for the most part repeats trends seen for Question 5 (see Figure 4). The control group starts out with a higher percentage agreeing with the safety statement, although this higher percentage in the control group is not statistically significant ($p=0.25$). Percent agreeing in the control group drifts upward between baseline and 6 months, without formal intervention, but with visits of study personnel to the workplace. The increase in safety knowledge among intervention workers is significantly greater than in the control group during this time period ($p=0.03$). However, quite distinct from the results of other significant survey questions, there is a slight *decrease* in the percent agreeing from 6 months to

12 months in the control group, despite implementation of the educational portion of the intervention.



The subject of Question 15 reflects confidence in knowledge of appropriate respirator use. As for the individual questions already discussed, control and intervention groups are not significantly different (p=0.31). The increase in the percent of intervention workers confident in their appropriate use of respirators was significantly greater (p=0.016) than the increase in the control group, in which the percent confident in their knowledge remained virually the same (see Figure 5). Percent agreeing in the intervention group remains nearly the same between 6 and 12 months and increases in the control group after partial intervention do not match the increase seen in the intervention group.

In several questions, percent agreeing was high at baseline, such that the potential for improvement and significant variation was low. This applies to Questions, 3, 8, 9, 11, 12, 13, and 14 (data not shown).



Question 12, a knowledge question about toxic dusts on work clothes, is an example of this. Both groups at baseline had near 90% agreeing with the safety statement (see Figure 6). The intervention group began with a slightly higher percent agreeing with the safety statement, and thereafter changed minimally. The greatest increase in percent agreeing, still a minimal change, occurred in the control group after intervention.

Question 14 (see Figure 7), addressing skin protection during use of potentially hazardous materials, more closely reflects trends seen in the statistically significant questions (1, 5, 10, 15) described above.

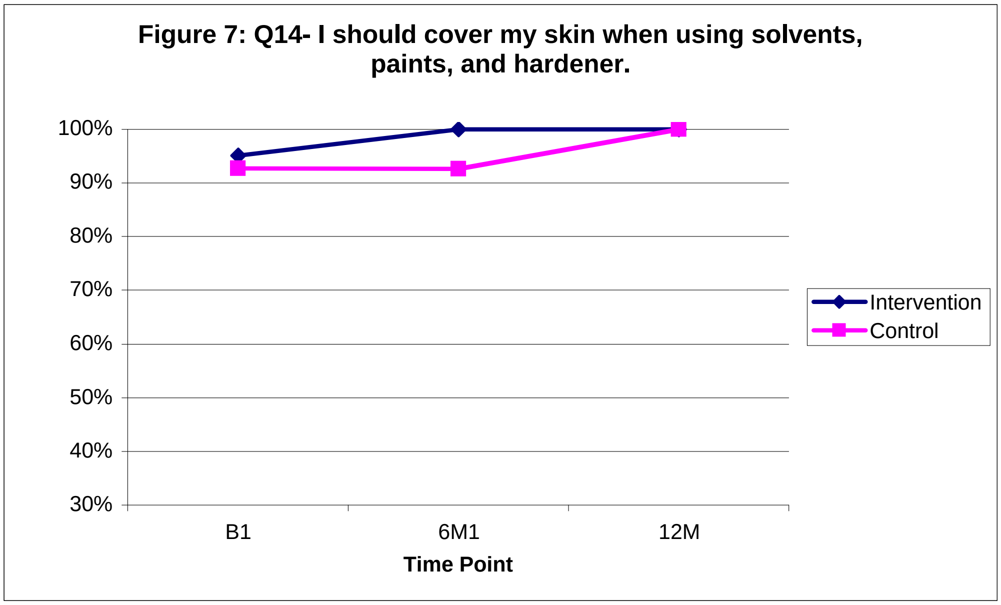
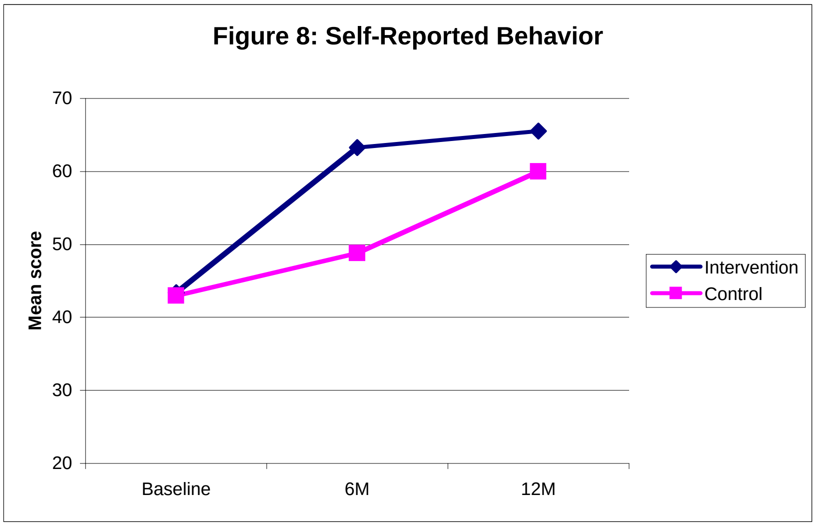


Figure 7: Q14- I should cover my skin when using solvents, paints, and hardener.
100%
90%
80%
70%
60%
50%
40%
30%
B1
6M1
12M
Time Point
Intervention
Control

Self-Reported Behavior

We observed significant improvements in both self-reported safety behaviors scores (see Figure 8) and observed behaviors after implementation of interventions.



Control and intervention study participants were nearly identical in mean Self-Reported Behavior score at baseline (42.95 and 43.39 respectively, $p=0.93$). At six months, the intervention group had increased their mean Self-Reported Behavior score by nearly 21% to 63.25. This steep rise was followed by a minimal but continued increase of > 3% in the Self-Reported Behavior score to 65.54 at 12 months. The initial increase at 6 months of Self-Reported Behavior scores in the intervention group represents a significant increase over scores in the control group ($p=0.019$)

As mentioned, the Self-Reported Behavior score of the control group also increased in the first six months. An increase of 12% from 42.95 to 48.79 occurred in the control group without the formal intervention, i.e. without educational training and formal behavioral feedback portions of the intervention. Again, despite not receiving the formal study intervention, all study shops were visited monthly by study industrial hygiene technicians.

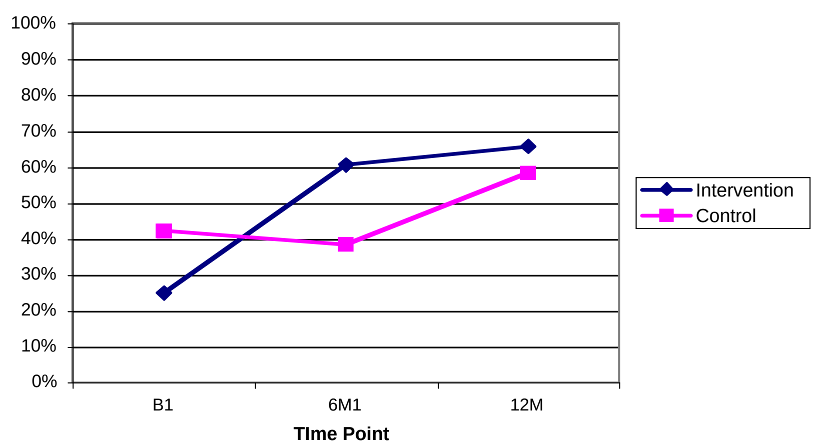
A much larger increase, of greater than 19% from 47.9 to 60 was seen in the control group's mean Self-Reported Behavior score at 12 months, after formal intervention, and including educational training (but excluding the behavioral feedback provided to the intervention group). Despite increase in mean Self-Reported Behavior score in the control group, the control group did not quite achieve as high a final score at 12 months as the intervention group. Further, comparison of increases in mean Self-Reported Behavior scores after intervention in both groups shows a greater improvement in the intervention group (the group with formal behavioral feedback); however this difference did not reach statistical significance (p=0.15).

Individual Self-Reported Behaviors

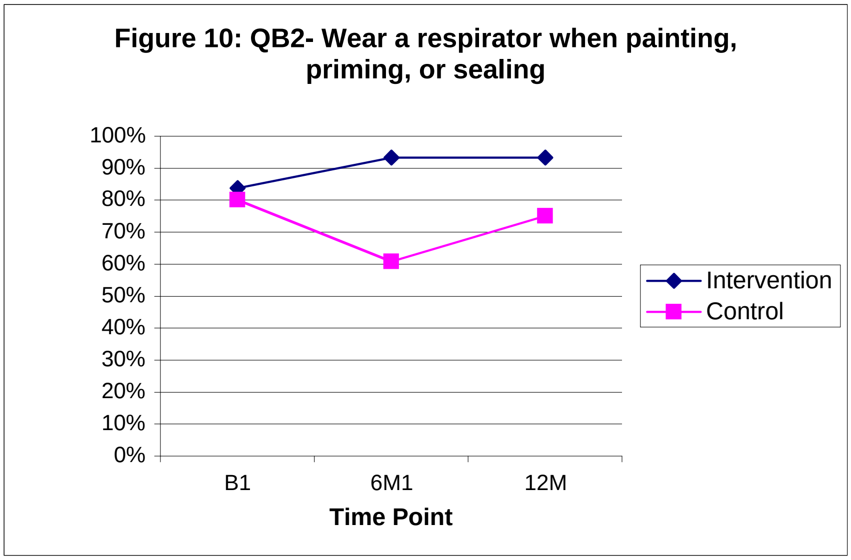
Self-reported behaviors involving respirators (Questions B2, B6, B8, and B10) and skin protection (Questions B4, B7, B9) were very responsive to intervention. These behaviors were the primary focus of educational training and behavioral feedback interventions.

Patterns of change in self-reported behaviors related to respirator use (Questions B2, B6, B8, and B10) correlate well with patterns observed for statistically significant increases of confidence in appropriate respirator use after intervention (Question 15 of the Knowledge and Attitudes Survey: "I know which respirator to use for each job"). Figure 9 shows a large increase in self-reported adherence to safe respirator behavior after intervention. The control group did not change much between baseline and 6 months, but did increase adherence after receiving the educational training portion of the intervention. However, the intervention group, having received behavioral feedback in addition to educational training, increased its adherence much more.

Figure 9: QB6- Wear proper respiratory protection when others are spray painting nearby.



Questions B6, B8, and B10 especially, are variations on this theme. In all four there is a statistically significant increase in adherence to appropriate respirator use. Responses to Questions B10 ("Clean respirator at the end of the day") had a nearly identical trend to Question B6 (see Figures 9 and #). Responses to Question B2 differed primarily in that there was high baseline adherence in both groups, and a large decline in adherence in the control group in the first six months (see Figure 10).



However, trends in Question B8 (“Wear supplied air respirator when in the booth”) are confounded by a large difference between baseline adherence in intervention and control groups, with the intervention beginning at a higher adherence. Deviating from the overall trend, the control group also increased its adherence to self-reported safety behavior after partial intervention more than the intervention group does after full intervention (see Figure 11). Questions B4, B7, and B9 all involved self-reported skin protection behavior (Figures 12 and 13).

Figure 11: QB8- Wear supplied air respirator when in the booth

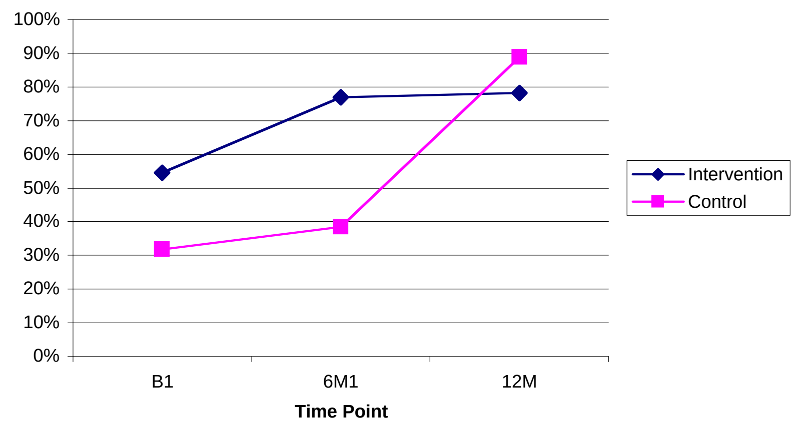
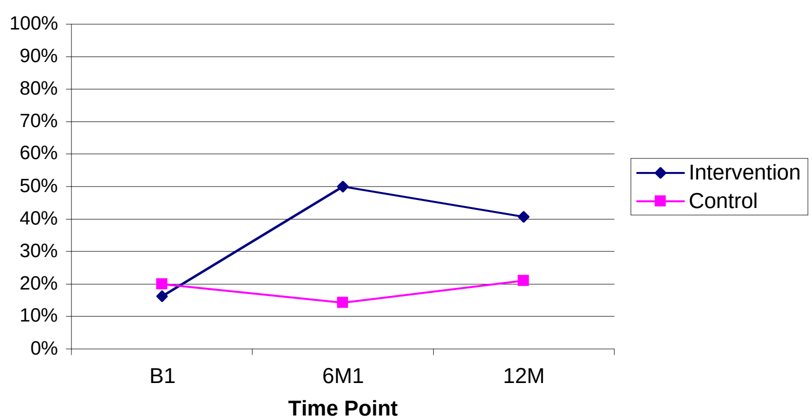
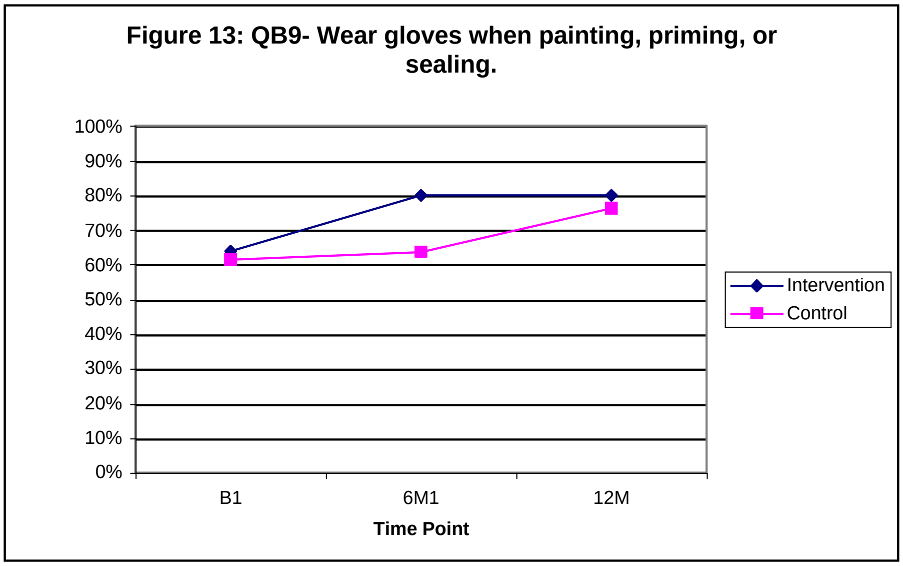


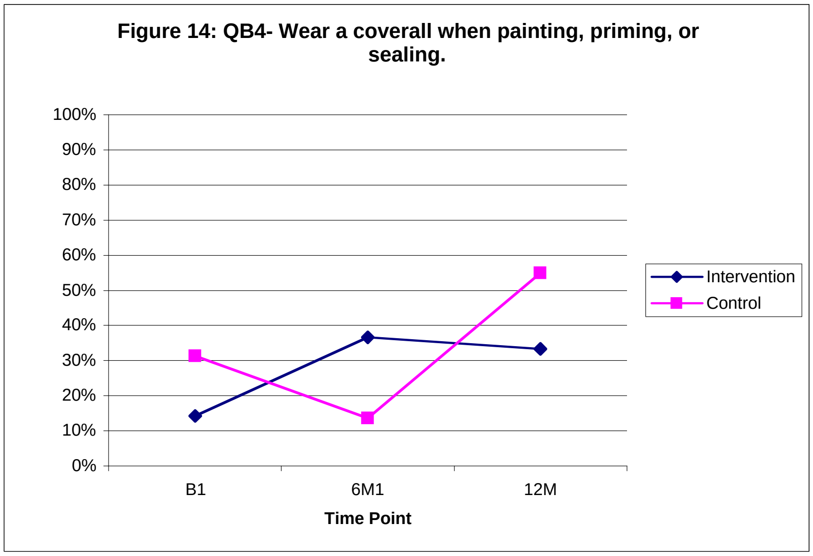
Figure 12: QB7- Wear face or eye protection when mixing paints.



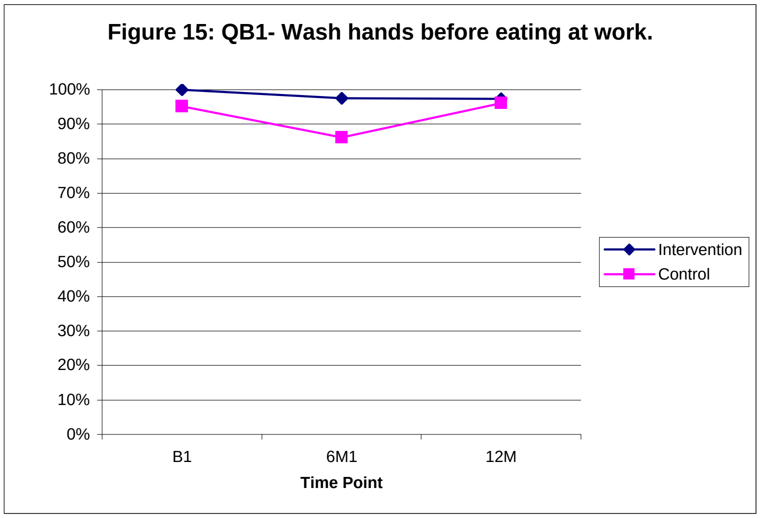


In both questions, self-reported adherence to skin-protection behavior was very similar at baseline in control and intervention groups. Thereafter, there was little change in self-reported adherence in the control group, whereas adherence greatly increased in the intervention group. Some of this self-reported behavior decreased from 6 to 12 months in Question B7 (wearing face or eye protection), but it was maintained in Question B9 (wearing gloves). Between 6 and 12 months post-educational training, the control group also increased their adherence, but not as much as the control group (see Figures 12 and 13).

Responses to Question B4 followed a similar pattern, with notable differences. Both groups began with low self-reported coverall use, although the control group's self-reported adherence was much greater (Figure 14). Self-reported coverall use greatly declined in the control group between baseline and 6 months then had a much greater increase after partial intervention than the increase in the intervention group. Season at time of intervention could be a confounder (e.g. wearing coveralls during a hot day is much more uncomfortable than on a cold day in winter).

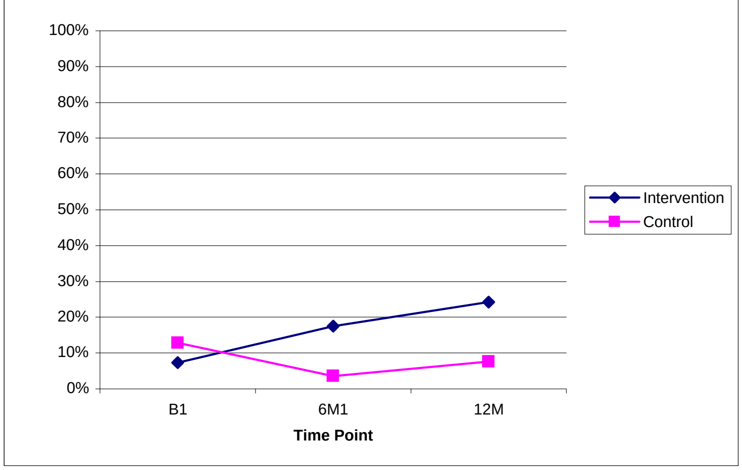


Unlike the previous questions, Questions B1, B3, and B5 asked study participants about safety behaviors that were included, but not the focus of, the educational and behavioral feedback interventions.



The subject of Question B1 was hand washing before eating at work. The mean percentage of workers reporting adherence to this behavior was very high at baseline in both groups, limiting potential for improvement. Deviating from all other self-reported behaviors, at 12 months, the mean adherence to hand washing was slightly lower in the intervention group and minimally increased in the control group (see Figure 15). However these differences were non-significant. Further, unlike most other behaviors, washing hands before eating at work may have been a habit with many workers or alternatively perceived as a hygiene issue instead of a safety behavior.

Figure 15: QB5- Read the MSDS.



The subject of Question B5, reading Materials Safety Data Sheets (MSDS), was likewise a safety-related behavior that was not a focus of the study intervention. Self-reported adherence to this behavior was extremely low in both groups at baseline. By self-report, adherence more than doubled in the intervention group in the first 6 months and continued to rise thereafter. In the control group, rates of adherence declined in the first six months, then increased slightly after partial intervention, but did not return to baseline adherence (see Figure 15). The rate of increase in adherence was significantly greater in the intervention group in the first six months than was the rate of increase in adherence in the control group after partial intervention. Although not a focus of study intervention, reading MSDS was a rarely adhered to behavior that seemed very responsive to our study intervention.

Relationship Between Self-Reported Behavior and Observed Behavior

As an additional measure to aid in approximation of actual behavior, we conducted systematic observation of safety behavior at major time points (baseline, 6 months, and 12 months). The observations for each person were grouped by behaviors related to safety practices during painting, including respirator use and glove use. See Appendix B for Behavior Checklist.

Observed respirator and glove use followed the general trend in Self-Reported Behavior and the Knowledge and Attitudes Survey: the most significant increases in safety behavior were seen in the intervention group after intervention, followed by the control group after partial intervention. The intervention group, having received both behavioral feedback and educational training components had a greater increase in safety behavior. Unlike trends in knowledge and attitudes and self-reported behavior, observed glove use declined slightly between 6 months and 12 months (see Figures 16a, 16b, and 16c).

We compared individual self-reported behaviors of workers with observations of their behavior. Observed behavior was highly associated with self-reported behavior. For Question B2, “I wear a respirator when painting, priming, or sealing.” >87% of workers reporting this behavior “sometimes” or more often were observed to adhere to this behavior >50% of the time. 12% of workers reporting this behavior “sometimes” or more often were observed to adhere to the behavior less than 50% of the time. Among workers reporting the behavior less than “sometimes”, 66% were observed to adhere <50% of the time, 33% > than 50% of the time (Chi-Square value=6.9, p=0.009).

Association was even stronger in 3 other behaviors analyzed. Of the participants that reported “I use the booth when painting, priming, or sealing” (Question B3) “some times” or more often, 73.5% were observed to use the booth 50% of the time or more often, and 26.5% were found to follow the safety behavior less than 50% of the time. Of the participants who reported less than “sometimes” adhering to use of the booth, 90% were observed to use the booth less than 50% of the time. Only 10% of workers reporting less than “sometimes” use were observed to engage in the safety behavior more than 50% of the time (Chi-Square value= 15.55, p=.<0.0001). Self-reported coverall use (B4), and eye protection (B7) were also highly associated with observed behavior (Chi-Square Value= 31.95, p<0.0001, Chi-Square Value= 9.2, p= 0.002). The final self-reported behavior we compared to observation was glove use (B9). This self-reported behavior was correlated with observed *nitrile* glove use but this was only borderline significant (Chi-Square Value=3.8, p=0.05).

Knowledge and Attitudes as predictor of Self-Reported Behavior

We used linear model analysis to examine whether worker Knowledge and Attitudes mean score and/or other certain worker subgroups had different Self-Reported Behavior scores. At baseline, we evaluated job title (painter, office worker, or technician), Group Assignment (intervention or control), race (Hispanic, White, Native American, or Native American/White), age, smoking, and Knowledge and Attitude mean score. At baseline, only the variables Knowledge and Attitude mean score, and Hispanic had significant effects (See Table 2). Workers with higher baseline Knowledge and Attitudes mean score had significantly higher Self-Reported Behavior scores at baseline (F Value= 7.4, p=0.008). Being Hispanic was also associated with a higher baseline Self-Reported Behavior mean score (F Value= 6.3, p=0.014).

We then looked at correlates of Self-Reported Behavior mean score at all times. When looking at all time periods, two sets of effects were seen: both Group Assignment (intervention or control), and Knowledge and Attitudes mean score were significant (See Table 3). Interestingly, we found a coefficient of 0.49 relating Knowledge and Attitude means score to Self-Reported Behavior mean score in the intervention group (p=0.005). A similar phase effect was seen in the control group, but did not reach statistical significance (Coefficient=0.14, p= 0.45).

Table 2: Linear Model Analysis of Self-Reported Behavior Mean Score: Intervention Group

Variables	Coefficient	p-value
Knowledge and Attitude Mean Score	0.49	0.005
Phase: Baseline	0	
Six month	12.25	0.012
Twelve month	13.98	0.006

The overall p-value for phase is 0.012.

Table 3: Linear Model Analysis of Self-Reported Behavior Mean Score: Control Group

Variables	Coefficient	p-value
Knowledge & Attitude Mean Score	0.14	0.45
Phase: Baseline	0	
Six month	-3.79	0.51
Twelve month	6.47	0.29

The overall p-value for phase is 0.28.

Discussion

The primary interventions implemented in this study, educational training and behavioral feedback (a modified behavior based safety approach), were well received by workers and managers and highly successful at improving worker knowledge about and attitudes towards personal protective equipment and safe work practices. Both combined Knowledge and Attitudes scores and Self-Reported Behavior scores significantly improved after intervention. These improvements in knowledge, attitudes, and self-reported behavior were generally sustained at 12 months despite discontinuation of the intervention at 6 months. In the language of behavior-based safety, this may represent adoption of fluency, that is, safe behaviors becoming habits.

To understand the impact of educational training and behavior feedback portions of the intervention, our group implemented a partial intervention, (including educational training, excluding behavior feedback), in our control group at 6 months. In the control group, the post-intervention increase in Knowledge and Attitude scores and Self-Reported Behavior scores was significant, but smaller than the increase in scores in the intervention group. For Knowledge and Attitudes, the difference between the rates of increase was borderline significant ($p=0.056$), indicating that the complete intervention, including behavioral feedback could be superior to educational training alone in promoting improvement in knowledge and attitudes. For Self Reported Behavior, the higher increase in scores in the intervention group was not significant ($p=0.15$). It is possible that our study needed greater power to detect differences in the effects of the two interventions. It is also possible that behavioral feedback contributes to sustainability of behavior change over time, making behavior habitual. A longer follow-up period after educational training would be required to investigate differential impacts of the two interventions on sustainability of behavior change and Knowledge and Attitudes change at one year. In addition, evaluation of the independent contribution of the administrative interventions and monthly visits may be needed to identify the most effective individual portions of the intervention.

Of the 14 questions on the Knowledge and Attitudes Survey, only four showed statistically significant changes over time. Three of these four questions involved glove-use, a major focus this intervention to help prevent dermal as well as respiratory exposure to isocyanates. Two of these questions were knowledge questions, (superiority of nitrile vs. latex, and necessity of changing contaminated gloves to maintain protection), and one was an attitude question measuring perceived barriers to glove use (gloves make it difficult to paint). The final survey question that showed significant change was an attitude question: confidence in knowledge of what respirator to use for each job. Questions that did not show statistically significant changes often had low variability (i.e. over 90% at baseline agreeing that skin should be covered when working with solvents, paints, and hardener). Elimination or replacement of some of these questions would likely improve the survey's ability to detect significant differences in knowledge and attitudes among workers.

Most individual questions about Self-Reported Behavior scores related to respirators and skin protection were very responsive to intervention and followed the general trend of greatest increase in scores after full intervention (intervention group between baseline and six months) and smaller increase after partial intervention (control group between 6 and 12 months). Coveralls differed slightly in that they were widely perceived as uncomfortable and less popular forms of personal protective equipment and were thus adopted at lower levels, but still followed trend of increased self-reported behavior after intervention.

In order to examine correlates of self-reported safety behavior at baseline, we used linear model analysis to evaluate the following variables: job title, group assignment (intervention vs. control), race, age, smoking status, and Knowledge and Attitude mean score. High Knowledge and Attitude mean score and Hispanic ethnicity both correlated with higher baseline Self-Reported Behavior mean score (p=0.008, and p=0.014). Our Knowledge and Attitudes Survey still requires validation. However, the significant correlation between the Knowledge and Attitudes Survey created by our group and Self-Reported Behavior makes this a survey a promising start towards a tool to identify auto body shop workers at higher risk for exposure, better target interventions to reduce exposure to isocyanates, and evaluate the efficacy of these interventions.

When looking at all time periods, group assignment (intervention or control), and Knowledge and Attitudes mean score were both significant variables affecting Self-Reported Behavior score. In the intervention group, we found a coefficient of 0.4913 relating Knowledge and Attitude means score to Self-Reported Behavior mean score (p=0.0046). Although a similar phase effect was seen in the control group, it did not reach statistical significance. The predictive value of Knowledge and Attitudes mean score for Self-Reported Behavior mean score was thus mediated by type of intervention. One interpretation of this result is that behavioral feedback could in fact have a significant effect on behavior outcomes, amplifying the behavioral effects of improvements gained from educational training. This could represent the formation of new fluent safety behaviors reinforced by practice and individual instruction.

This study adds to the literature on the effectiveness of occupational safety interventions to reduce worker dermal and respiratory exposure to workplace chemicals. We took a multifaceted approach to intervention and used novel surveys to measure significant post-intervention improvements in knowledge, attitudes and self-reported behavior relevant to decreasing respiratory and dermal exposure to isocyanates. Observation of worker behavior was consistent with self-reported behavior and further supports use of the survey measures. Because our design incorporated partial intervention, we were further able to compare effects of participatory educational training alone and in concert with behavioral feedback, finding a trend toward improved outcomes with the combined intervention that did not quite rise to statistical significance. We were also able to observe the durability of changes in knowledge, attitudes, and behavior after comprehensive intervention. Many of the elements of the successful educational training and behavioral feedback interventions used in this study were carefully designed for auto body shops and will be relatively easy to implement throughout the industry, with the potential to greatly reduce worker exposure to isocyanates.

Limitations of our study include the relatively small sample size of 103 workers; the number of workers in our study was possibly too small to measure the effect of behavioral feedback. Although auto body shops were randomized to control and intervention groups, it is possible that differences in shop culture and management behavior could have affected our results in ways that we have not yet characterized, but can be further analyzed. Reliability of self-report is another concern. Comparison of some individual workers' self-reported behaviors on our survey with systematic observations of the same workers' safety behavior at work, showed high association between these measures of behavior ($p=0.05$ for nitrile glove use to $p=<0.0001$ for use of coveralls). This high association makes it likely that self-reported behavior on our survey is a good approximation of worker's actual behavior. Yet observed behavior is also a proxy for actual behavior. For this reason, quantification of worker dermal and respiratory exposure to isocyanates may be needed to fully evaluate the effectiveness of an intervention to reduce exposure. Unfortunately, there are currently no good quantitative methods to monitor dermal exposure, and we lack adequate urinary biomarkers for this purpose. We addressed this lack of quantitative methods, and a lack of pre-existing validated Knowledge, Attitudes and Self-Reported Behavior surveys by creating new instruments. The surveys employed have the potential to provide valuable measures of important determinants of exposure-related behavior; these surveys may benefit from further refinement and correlation between our measures of behavior and actual exposure.

Literature on interventions to prevent isocyanate exposure and dermal exposure to other workplace chemicals is limited. There has been little characterization of critical knowledge and attitudes that underlie behaviors that reduce dermal exposure. However, comparison of our findings to Geer et al.'s is intriguing [32]. Geer et al. studied knowledge, attitudes, and perceptions of workplace dermal hazards as recorded on a survey (KAP), and used a semi-quantitative method incorporating both observed behavior and self-report (DREAM) to evaluate these workers' exposure in diverse industrial workplaces. They found no statistically significant associations between their KAP survey and the DREAM measure of dermal exposure. By contrast, our Knowledge and Attitudes Survey score *was* significantly associated with Self-Reported Behavior score at baseline, as was the variable Hispanic ethnicity. The differences in our results may relate to survey content; the content of our survey was closely tailored to the workplace dermal and respiratory exposures in the auto body industry, whereas Geer et al. surveyed workers at diverse industrial workplace settings. However, the relationship between Knowledge and Attitude Survey score and self-reported behavior in our study appears to be dynamic, changing in response to differences in intervention and phase of study.

Geer et al also evaluated individual worker characteristics, answers to questions on the KAP survey, and safety behavior and dermal exposure. They found significant negative association between precautionary behavior and either high perceived-barriers to use of personal protective equipment, or being in the age group 40-49 years [32]. There were marginally positive associations between protective behavior and two variables: worker self-efficacy with respect to personal protective equipment use, and the group workers with10-20 years of experience. By contrast, age was not significant in our model; smoking and job title were not significant either. However, among demographic variables, we did find Hispanic ethnicity to be a significant correlate of higher Self-Reported Behavior scores at baseline. Evaluation of years of experience in the industry may be a good future addition to variables examined in our survey.

In terms of knowledge and attitude correlates of safety behavior and dermal exposure, we found a number of individual questions on our surveys that changed significantly and are worthy of further investigation. Two of these were knowledge questions, (superiority of nitrile vs. latex, and necessity of changing contaminated gloves to maintain protection), and two questions were attitude questions: one measuring perceived barriers to glove use (gloves make it difficult to paint) and one measuring confidence in knowledge of what respirator to use for each job. This is very much in keeping with Geer's finding of positive (though not quite statistically significant) correlation between protective behavior and self-efficacy and significant negative correlation between protective behavior and high perceived-barriers. It also resonates with Vela Acosta et al's finding that farm workers with external health locus of control were less likely to adopt safety behaviors [21].

This study has identified several possible correlates of protective behavior to reduce exposure to isocyanates in auto body shops in the context of a successful comprehensive educational training and behavioral feedback intervention. As our understanding of the determinants of safe behavior and behavior change in auto body shops improve, greater refinements to interventions will be possible and can find wide implementation in the auto body industry and in other industries in which dermal exposure is a concern. A 2007 paper by Whysall encouraged precisely this sort of detailed analysis of stage of change of workplaces in the design of interventions [33]. There is a great deal of opportunity to perform additional analysis on our data and characterize key knowledge and attitudes for individual workers that correlate with enhanced self-reported protective behavior and behavior change. Analysis of the “shop effect”, the effect of workplace culture and/or management factors, is likely to further our understanding of the interactions between individual and workplace stages of change.

In summary, a multi-faceted intervention including educational training and administrative changes alone or in combination with behavioral feedback was effective in increasing observed and self-reported safety behavior and use of PPE among auto body workers at risk for exposure to isocyanates. These changes in behavior were accompanied by increased safety knowledge and improved attitudes towards use of PPE and exposure-reducing behavior. The more comprehensive intervention, including behavioral feedback, improved knowledge, attitudes, and self-reported behavior most, but this difference did not rise to statistical significance. Two knowledge questions and attitude questions about perceived barriers and self-efficacy in use of PPE underwent significant improvements during the study period and may be useful targets for behavior change. Knowledge and Attitude mean score, group assignment (intervention vs. control), and Hispanic ethnicity both correlated with higher Self-Reported Behavior mean score. The effect of Knowledge and Attitudes mean score on Self-Reported Behavior mean score was thus mediated by type of intervention, indicating that behavioral feedback could in fact have a significant effect on behavior outcomes, amplifying the behavioral effects of improvements in knowledge gained from educational training. Wide adoption of interventions using combined educational training and behavior feedback could significantly reduce respiratory and dermal exposure to isocyanates in auto body shops, and decrease the risk of occupational asthma for these workers. The interventions, knowledge attitude, and behavior measures examined in this study have broad applicability to dermal exposure reduction in many occupational settings.

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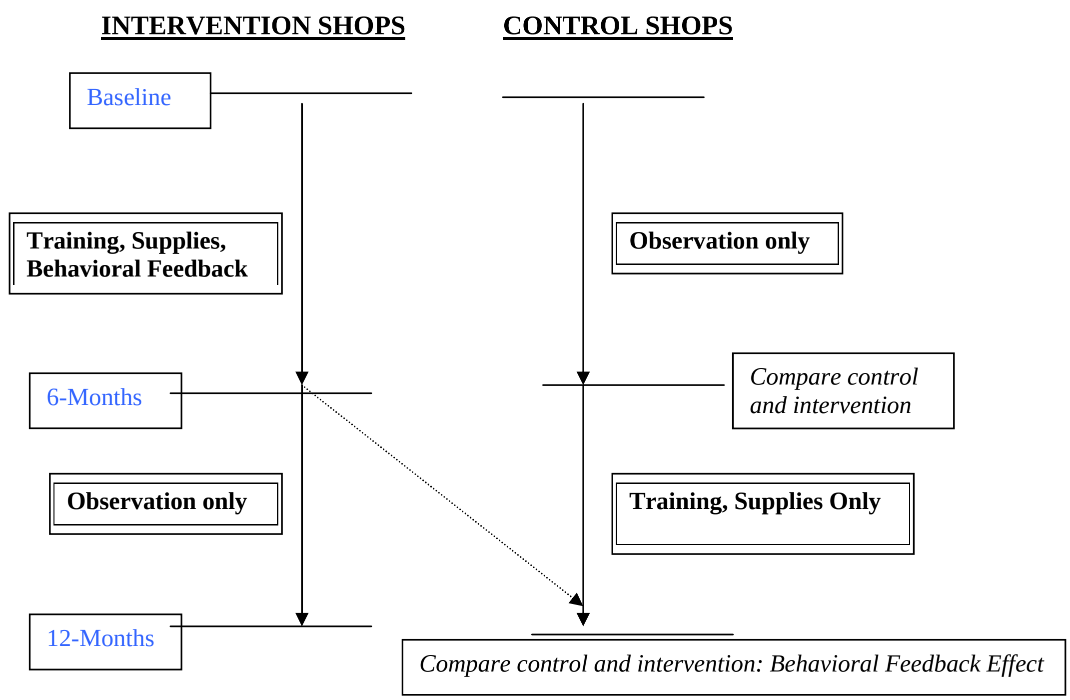
Appendix A

SMASH STUDY DESIGN



FIRST WEEK OF INTERVENTION:

- Checklist of target behaviors pre- and post-training
- Fit testing and respirator training
- Opinion questionnaire
- Health and Safety training session
- Air sampling inside/outside respirator
- Wipe sampling – surface and skin decontamination, PPE breakthrough
- Worker/Manager evaluation of intervention
- Shop questionnaire with manager / Controls checklist / Recommendations
- Shop manual, hazard communication and respiratory protection programs

MONTHS 1-6 OF INTERVENTION:

- Individual behavioral observations/checklist and feedback meetings
- Replenish SMASH supplies (gloves, decontamination solutions, etc.)

EVALUATION AT 6-MONTHS AND 12-MONTHS:

- Checklist of target behaviors
- Fit testing
- Opinion questionnaire
- Air sampling
- Wipe sampling
- Worker/Manager evaluations

Appendix B

CHECK LIST OF TARGET BEHAVIORS (11-4-03)

Shop ID: ______ Visit: B1 B2 6-mos 12-mos Observer(s): ___________ Date: __________ Day of week: _____________

Worker ID: ___________ ***Instructions:*** *Record number of times you observe the worker perform each safety practice safely & number of times you have a concern. Observe a maximum of five tasks per worker.*

Safety Practice	Safe	Concern	Comments	
1. PAINTING Š PRIMER, SEALER, BASE COAT, CLEAR:				
2. Do all painting inside booth				
3. Wear supplied air respirator or best available respirator				
4. Wear nitrile gloves				
5. Wear coveralls				
6. Wear long sleeves if coverall not available				
7. Wear head covering				
8. Wear eye protection				
9. Keep respirator on while in booth				
10. MIXING PAINT:				
11. Wear cartridge respirator with OV/PP				
12. Wear nitrile gloves				
13. Cover skin with coveralls				
14. Wear long sleeves if coverall not available				
15. Wear eye protection				
16. Close all containers immediately after use				
17. Clean up any isocyanate spills on the bench immediately with paper towels and provided surface cleaning product.				
18. GUN CLEANING:				
19. Clean gun and gun cup in gun cleaning machine				
20. If no gun cleaning machine, clean gun in well ventilated area (ventilated mixing room or next to a downdraft prep station)				
21. Wear cartridge respirator with OV/PP				
22. Change nitrile gloves before gun cleaning				
23. Cover skin with coveralls				
24. Wear long sleeves if coverall not available				
25. Wear eye protection				
26. SANDING, GRINDING, WELDING:				
27. Use LEV on sander if available				
28. Wear respirator with HEPA filter for dry sanding, grinding				
29. Wear nitrile gloves for dry and wet sanding				
30. Cover skin with coveralls				
31. Wear long sleeves if coverall not available				
32. Wear eye protection				
33. OTHER TASKS:				
34. Wear nitrile gloves for un-taping				
35. Wear nitrile gloves for polishing, compounding or buffing				
36. Close all containers immediately after use				
37. Clean respirator mask after each use				
38. Store cleaned respirator in a clean sealed bag				
39. Clean hands with cleanser provided before using the bathroom, before eating and at the end of work shift				

40. LIST TASKS OBSERVED FOR THIS PERSON: a. _________________________ b. _________________________

c. _________________________ d. _________________________ e. _________________________

Appendix C

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Motivational Graphs

Appendix D

Safe
Methods for
Autobody
Shop
Health

OPINION QUESTIONNAIRE
"Knowledge and Attitudes Survey" ID# _______

Shop ID: ______ Visit: B1 B2 6-mos. 12-mos. Recorder: ________ _

Date: __________

1- Strongly disagree 2 – Disagree 3 – Undecided 4 – Agree 5 – Strongly Agree
9 – Not Applicable

A. Using the answers above [or on the card], please tell me how much you agree or disagree with the following statements:

____1. Wearing gloves makes it more difficult for me to paint well.

____2. I'm doing enough to protect myself from toxic materials.

____3. Using the booth for all painting helps protect my co-workers.

____4. a. It's too hot in the summer to wear coveralls for painting in the booth.
____ b. It's too hot in the summer to wear coveralls for priming.

____5. Nitrile gloves give me better protection than latex gloves.

____6. I can paint just fine wearing a supplied air respirator.

____7. a. My co-workers don't care if I paint on the shop floor.
____ b. My co-workers don't care if I prime on the shop floor.

____8. It's hard to find a pair of clean gloves.

____9. My respirator may not protect me if it is dirty.

____10. I don't think it's necessary to change my gloves if they get contaminated.

____11. Wearing a respirator is not important to my health.

____12. My work clothes may carry toxic dusts to my car or house.

____13. There is no time to wear or change gloves.

____14. I should cover my skin when using solvents, paints and hardener.

____15. I am not sure which respirator to use for which job.

____16. Sanding dust is just part of the job – there's no way to reduce it.

Appendix E

Safe
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OPINION QUESTIONNAIRE
"Self-Reported Behavior"

ID # _______

1- Always   2- Most of the time   3- Sometimes   4- Occasionally   5 – Never
9- Not applicable

B. Using the answers above [or on the card], please tell me how often you do the following:

____1. wash your hands before eating at work

____2. a. wear a respirator when painting or sealing
____ b. wear a respirator when priming

____3. a. use the booth when painting or sealing
____ b. use the booth when priming

____4. a. wear a coverall when painting or sealing
____ b. wear a coverall when priming

____5. read the MSDS to learn about a toxic product and how to protect yourself

____6. wear the proper respiratory protection when others are spray painting nearby, outside the booth

____7. wear face or eye protection when mixing paints

____8. wear the supplied air respirator when spraying in the booth

____9. a. wear gloves when painting or sealing
____ b. wear gloves when priming

____10. clean your respirator at the end of the day if you have used it that day