Final Progress Report

A Randomized Intervention in Collision Repair Shops

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List of terms and abbreviations

AASP-MN – Alliance of Automotive Service Providers – Minnesota

CARSS – Collision Auto Repair Safety Study

GFCI – ground fault circuit interrupter

LOTO – lockout tagout

MN – Minnesota

NAICS – North America Industry Classification System

NIOSH – National Institute for Occupational Safety and Health

NORA – National Occupational Research Agenda

OSHA – Occupational Safety and Health Administration

PPE – personal protective equipment

SIP – Shop Improvement Plan

Abstract

Collision repair shops are mostly small businesses with fewer than 5 employees. They face unique challenges in implementing health and safety regulatory requirements. Owners are often unaware of safety laws, and often seek information from easily accessible channels such as suppliers. These sources lack training and their financial interests may play a role in the type and amount of information provided. In addition owners are often reluctant to develop and enforce safety rules. Furthermore,, owners do not regard the identification and control of risks as a priority and have limited resources to hire professional safety consultants. Collision repair technicians encounter a wide variety of physical and chemical hazards during vehicle repair, assembly and painting. The Collision Auto Repair Safety Study (CARSS) was designed to assist business owners located within 50 miles of the Minneapolis-St. Paul metropolitan area with identifying and implementing improvements to address isocyanates, solvents, fire and explosion, flying objects and dust, noise, and electrical hazards.

Over a six-year period, we conducted employee exposure assessment studies, focus groups, created collision repair industry-specific training modules, safety programs, evaluation forms, work-practices questionnaires, newsletters, hazard info sheets, and implemented intervention activities. The intervention had two parts: (1) A health and safety assessment was conducted at baseline and owners were assisted with creating and implementing a Shop Improvement Plan. Technical assistance included quarterly reminders and newsletters, safety training, and providing respirator fit test and medical evaluation for respirator users. Another health and safety assessment was conducted one year post enrollment. (2) Each business received up to three reminder postcards, but not other contact was initiated by the study staff. A health and safety assessment was conducted 2 years post enrollment.

Employees' exposures to solvents and dust during operations other than spray painting and paint gun cleaning did not exceed the current occupational exposure limits. However, noise exposures were variable and we documented elevated noise exposures in one facility that handled a large number of vehicles. The CARSS intervention resulted in statistically significant improvements in many aspects of health and safety. Improvements were greatest in areas for which CARSS was able to offer technical assistance such as respiratory protection, Right-to-Know training, and personal protective equipment for the ears, eyes, and skin. The smallest improvements were seen in areas related to electrical and machine safety and the paint booth and mixing room. Most changes remained in place at the time of the two-year follow-up.. Improvements were more likely to continue if the deficiencies to be corrected had been included in a formal Shop Improvement Plan.

Collision shop owners can improve safety and health in their business if they receive consistent guidance regarding the issues to be corrected and follow-up is done primarily in person. The availability of free assistance free was an incentive for participation. Web-based resources can be a valuable tool to reach a large number of businesses, but improvements to the site functionality are necessary to ensure its viability.

Section 1

Significant (Key) Findings

Employees' exposures to solvents and dust during operations other than spray painting and paint gun cleaning did not exceed the current occupational exposure limits. Noise exposure monitoring indicates that some employees may need to be included in a hearing conservation program. Vibration was not found to be a major concern. The risk of hip and back stress is increased by the use of footwear with minimal ankle support. Several electrical and fire hazards were prevalent: lack of GFCI-protected circuits in areas where electrical tools were used and water was present, improper or inexistent grounding and bonding of the containers of flammable liquids, locked and/or obstructed emergency exits, improper storage of oxygen cylinders, damaged light covers in the paint booths, etc.

Employees and owners noted difficulty in staying informed about health and safety regulatory requirements and updated technologies and materials that offer better hazard control. Employers were hesitant to set and enforce safety and health rules. Employees perceive owners to be unwilling to dedicate the resources required to make the workplace safer and provide personal protective equipment. Both groups felt insurance reimbursement practices placed undue production pressure on employees. Employers were conflicted about allowing employees a certain level of independence while also maintaining a safe workplace. From the employee perspective, owners frequently fail to provide adequate personal protective equipment and make improvements needed to ensure safe work.

The first year of the intervention consisted of baseline and 1 year evaluation visits, as well as quarterly follow-ups. Owners received assistance with setting goals for improving safety and health in their businesses by creating a formal Shop Improvement Plan, quarterly newsletters, and being given free access to safety information and training, and services such as respirator fit test and medical evaluation for respirator users. After 1 year of study participation, statistically significant improvements occurred in many aspects of health and safety. Improvements were greatest in areas for which CARSS was able to offer technical assistance: respiratory protection, Right-to-Know training, and personal protective equipment for the ears, eyes, and skin. The smallest improvements were seen in areas related to electrical and machine safety, and the paint booth and mixing room.

The second year of the intervention consisted of sending owners between 1 and 3 reminder postcards regarding available resources available, however, in-person contact was not initiated by study staff. Most changes remained in place at the end of the 2nd year. Improvements were more likely to continue if the deficiencies to be corrected had been included in a formal Shop Improvement Plan.

Delivering safety information using web-based technology is a viable option in assisting shop owners with increasing compliance with OSHA standards, and a convenient way to provide specific safety information for owners and employees.

Translation of Findings

We recommend that the evaluation of health and safety within small businesses include a comprehensive evaluation of the work environment. Assessment of auto collision repair shops revealed problems related to regulatory compliance, respirator use, explosion hazards, blocked exits and fire extinguishers, and other problems likely to place workers at high risk of injury. Focus on one problem may leave many serious problems undetected. The assessment process

should follow a methodical pattern of risk assessment. Absent this methodical process, important hazards are likely to be missed.

We also recommend that in the shops with a high-volume production employee exposure to noise is evaluated during the busiest times. Absent the means to do so, the pro-active approach of including the technicians in a formal hearing conservation program is recommended. Whenever possible, tool noise information provided by the manufacturer should be evaluated prior to purchasing new equipment, with the best option being the selection of tools that generate noise levels below 85dB. Storage of paints and other flammable materials should be confined to rooms that meet the OSHA standard 1910.106 requirements. Visualization of the airflow patterns in the paint mixing/storage room can provide immediate information about the adequacy of the ventilation system.

A large library of safety program templates, safety training videos and fact sheets, as well as check-list have been created for the collision repair industry and are available on the study website (www.repairsafety.com). The majority of these documents have been translated into Spanish. The website allows business owners to manage most of the OSHA-required safety training and programs in a cost-effective manner.

Outcomes/ Impact

1) potential outcomes: We recommend that future interventions to assist small businesses with safety and health improvements provide opportunities for business owners to select and prioritize the items to be addressed, as well as provide quarterly follow-up in person and low-cost and easily accessible information and resources.

The majority of the businesses lacked written safety programs and policies and were not up to date with respiratory protection training or training on the hazards of the chemicals used. The large majority of the respirator users had not been medically evaluated and cleared to wear the equipment assigned, and annual fit test was rarely performed. With the exception of respirator fit test, all other documents/training needs were met by the study website. Other hazards can be identified using the safety survey available on our website along with numerous checklists created for specific items such as jacks and jack-stands, ladders, electrical hazards, welding safety, and chains, slings and ropes.

Tool manufacturers are encouraged to include technical specification information pertaining to the noise levels generated by the tool when used as intended, as well as guidance regarding noise levels that are considered acceptable. Selection of ear plugs based on field-testing of several models is likely to increase workers' use of hearing protection, and is strongly recommended

2) intermediate outcomes: The data on self-reported work practices as well as the baseline safety assessment results were used to inform a joint grant proposal for a collaborative effort with two technical colleges in MN that aims at ensuring that vocational college students pursuing a degree in collision repair receive standardized and comprehensive safety and health information specific to their trade. The data on owner-administered business safety assessments will be used to inform changes of the assessment instrument. We are participating on-going discussions with a trade association and MN OSHA Workplace Consultation Program to develop a self-certification program for collision repair shops.

3) end outcomes: Post-intervention personal exposures were not quantified. However, significant improvements in shop health and safety are expected to decrease the injuries and illnesses caused by noise, solvents, isocyanates, dust, and fire and electrical hazards.

Section 2

Background for the project

Small businesses are a major source of employment in the United States. In 2008, there were approximately 34,500 automobile body, paint, and interior repair and maintenance shops (NAICS code 811121) employing just over 223,000 people in the United States. Fifty-five percent of collision repair shops had fewer than four employees and 95% had fewer than 20 employees.[1] Although small employers represent a large portion of workers, health and safety, services in these businesses are often underdeveloped and at times altogether missing.[2]

Collision repair technicians encounter a wide variety of physical and chemical hazards during vehicle repair, assembly, and painting. Chemical exposures to isocyanates during spray painting and the use of engineering controls and personal protective equipment (PPE) have been well documented in this industry.[3-10] However, other aspects of workplace safety including fire, explosion, electrical and machine-related hazards, and the programs required to manage these hazards, have not been examined in detail.

Previous health and safety intervention research in workplace settings has often been limited by the failure to apply the principles of rigorous scientific study design, lack of a theoretical framework, and relatively small sample sizes.[11-13] Furthermore, only infrequently have interventions integrated the three levels of the exposure control hierarchy (engineering, administrative, behavioral) recommended by NIOSH and the Office of Technology Assessment.[14-16]

Small businesses have additional problems in the conduct of interventions with respect to sample size[17]shop recruitment, organization of intervention programs at a large number of geographically dispersed sites, and responding to the needs of workers and owners representing a wide range of attitudes and beliefs with regard to health and safety.[18,19] There is almost a complete lack of randomized interventions in small businesses.[20] Barriers to successful implementation of hazard controls include lack of worker training, lack of implementation of OSHA standards, negative effects of hazard controls on productivity, discomfort using personal controls, and worker perception of lack of management support for hazard control improvements.[21-23]

Some studies have shown improvements in workers' knowledge and attitudes, but changes in worker behavior have been more difficult to achieve.[21,22,24] These studies may not have been successful because attempts to change worker behavior should not occur in isolation from changes in management structure.[25] Furthermore, workers describe a lack of decision-making power and low levels of management concern as barriers to improving workplace health and safety[24]. It is clear from studies of health and safety in larger businesses that management and labor participate in a dynamic interaction with exchange of ideas and information. This interaction plays an important role in determining the nature and success of workplace health and safety programs.[26-30] Even the best training program will have only limited success if management does not actively support its development, implementation, and maintenance.[31] Management or worker mistrust and suspicion detract from the likely success of a program.[32] Managers are responsible for program direction and goals, but employees must be given authority and responsibility in accomplishing these goals and ensure employees are educated and supported.[29,33]

In general, there is a lack of knowledge about barriers and effective strategies to reduce hazardous exposures in small businesses.[34] Behavioral and management studies of small business establishments have noted consistent problems with clear communications and organization within the business, limited owner perspectives as to their ability to impact health and safety, a highly competitive business environment, and lack of technical expertise.[35] Thus, a critical component of work site intervention research involves issues related to management-employee relations.[36-38] Kogi has used the active engagement of shop owners and workers to improve the health and safety of workers within small enterprises.[39] In our current Minnesota Machine Guarding Study, management and employee perceptions of work practices are correlated with each other as well as with objective measures of shop safety. Furthermore, the presence of labor-management safety committees is positively associated with better shop safety.[40] This supports the work of Kogi[39], in emphasizing the active engagement of workers and owners in improving workplace health and safety.

Specific aims

The specific aims of this project were:

Aim 1: Evaluate small (2-19 employees) collision repair shops for exposures to workplace hazards, the availability and use of engineering controls and personal protective equipment, and health and safety program management;

Aim 2: Develop and pilot test intervention activities aimed at improving employee and owner health and safety in the auto collision repair industry;

Aim 3: Implement and assess the effectiveness of a peer-based intervention in improving health and safety practices and lowering exposures to physical and chemical hazards in auto collision repair shops; and

Aim 4: Develop guidelines for implementing health and safety interventions in this industry and disseminate these guidelines through the Alliance of Automotive Service Providers (AASP) and other trade groups.

Methodology

Planning model: Intervention mapping provided the conceptual framework for study planning. Intervention mapping involves a step-by-step process that integrates behavioral theory, epidemiologic evidence, and information from the target population to arrive at a specific set of intervention objectives and strategies.[41] This model was chosen for its applicability to a wide variety of settings where there may be differing views with regard to the implementation of health and safety programs, a wide-range of environmental needs, and it is important to set site-specific performance objectives.[42]

Behavioral model: Social Cognitive Theory served as our behavioral model for intervention design.[43,44] Social Cognitive Theory was selected because of its applicability to a wide range of problems as well as its flexibility with regard to the incorporation of environmental factors within the model. Social Cognitive Theory was used to understand underlying shop-specific determinants of health and safety and as means of tailoring interventions to owners and employees within each shop. The investigators have used Social Cognitive Theory in other small business research and found it to be highly predictive of shop-related safety.[40]

Methods used in accomplishing each aim are summarized below. Detailed information is available in the peer-reviewed publications referenced herein.

Aim 1

A comprehensive literature review was conducted to identify the body of knowledge regarding employees' exposure to hazards commonly encountered in collision repair facilities. These include solvents, isocyanates, dust, noise, electrical and fire hazards. Sampling protocols were designed for assessing exposures to noise, dust and solvents. [details in Bejan et al, 2011[45]] Ergonomic evaluations of the work performed by body technicians and painters was conducted in two facilities.

Aim 2

An industry-based Advisory Board was established to more clearly define overall program objectives. In collaboration with the Alliance of Automotive Service Providers of Minnesota (AASP-MN) equipment and materials suppliers were interviewed. Focus groups were conducted with business owners and employees to identify attitudes and beliefs regarding safety in the workplace. [details in Parker et al, 2012[46]] A technical Advisory Board consisting of health and safety professionals representing regulatory agencies and private consultants provided feed-back and guidance in designing the business assessment form and data collection strategy.

In collaboration with the above Boards outcome measures were identified, along with partner shops and eligible participant population, and an intervention implementation protocol was established. All materials and protocols were pilot tested in 4 businesses. [details in Brosseau et al, 2014[47]]. The study website was developed. A protocol was designed to ensure continuous verification of the agreement between the two trained evaluators that completed the shop visits.

Aim 3

*Shop recruitment***:** A sample frame of 273 collision repair shops located within approximately 50 miles of the investigators' office was developed from the Dunn and Bradstreet database and the Alliance of Automotive Service Providers (AASP-MN) membership directory. Business were eligible to participate in the study if: (1) In business for at least one year prior to recruitment; (2) At least two people working in the shop – this may have included the owner; (3) At least 75% of business was in auto collision repair apart from glass replacement; and (4) the business had a functioning paint booth.

Business assessment form (the shop survey): The business evaluation form (the survey) consisted of 92 "yes/no" questions organized into the following sections: 1) safety and chemical right-to know training, 2) emergency planning, first aid and fire prevention, 3) management of compressed gases, 4) paint booth and mixing room, 5) ergonomics, 6) electrical and machine safety, 7) hearing, sight and skin protection and 8) respiratory protection. To assist owners with prioritizing corrective actions, the survey items were also ranked by severity as follows:

- *Critical*: Items that had the potential to cause serious injury to an employee *or* immediate damage to the facility (e.g., lack of fire suppression in the paint booth).
- *Highly Important*: Items that might cause employee injury or long-term health issues or damage to the facility (e.g., fit testing not conducted annually).
- *Important*: Items that might cause non-serious employee injury and illness (e.g., no eye wash station present in a shop where employees handle corrosive liquids; paint booth filters are not changed regularly).
- *Other*: Items not immediately hazardous that could be fixed relatively easily and ensure regulatory compliance (e.g., emergency action plan is reviewed once a year with all employees; OSHA 300 log is maintained).

Intervention protocol: The intervention was divided into two phases. Phase 1 was the first year of participation and included all study shops. Phase 2 was a follow-up in which businesses were evaluated approximately two years after their baseline evaluation.

Phase I

Each business was visited on four separate occasions. During the first visit, a comprehensive health and safety evaluation was completed and the shop owner and workers were asked to complete a safety climate survey and a survey of self-reported work practices. At the second visit, a Shop Improvement Plan (SIP) was developed with the owner. A detailed SIP was subsequently sent to the owner. The SIP described the steps needed to implement each recommendation selected by the owner and indicated the target completion dates. User accounts for shop owner and workers were created on the CARSS website. During the third visit, the progress made during the first quarter of study participation was assessed and shop owners received additional guidance and materials as needed. The fourth visit (1-year follow-up) was scheduled approximately 12 months after the baseline evaluation. Businesses were evaluated using the same assessment instrument and owners and employees were asked to complete surveys. [details in Parker et al, 2014[48]]

Phase II

Each business received up to three reminder postcards with information about available study resources. No contact was initiated by the study staff. The 2-year follow-up visit was scheduled

24 months after the baseline visit. Owner and worker surveys were not collected at the year 2 visit. [details in Bejan et al, 2014[49]]

Data analysis: Data were entered in Microsoft Excel and analyzed using SAS (SAS version 9.2; SAS Institute Inc., Cary, NC). A business safety score was computed for each participating shop. Business safety scores are expressed as the *percent* of applicable survey items present at the time of the baseline and follow-up evaluations.

Not all questions were applicable within all shops. The fewest number of applicable questions was 72 and the greatest was 91. For example, if a business used powered air purifying respirators, questions concerning fit testing were not applicable. Similarly, if a business was not using air-supplied respirators, questions concerning the air-supply system were not applicable. Each survey question evaluated an item of concern for health and safety in collision shops. If an item was either missing or inadequate a recommendation was provided in the survey report provided to the owner. The designation "missing/inadequate" was used to describe a variety of situations. For example, elements of a safety program were evaluated only if a written safety program was present; an item was present but incomplete (e.g., the training record indicated that training was completed by fewer than 50% of employees); or the item was present but not used or it was out of order (e.g., carbon monoxide monitoring equipment for air-supplied respirators).

A subset of 53 business safety assessment questions was designated for further analysis. Criteria used to select these questions were: (1) the item could be verified by the industrial hygienist; and (2) the item was considered *critical, highly important,* or *important* and/or an area that was frequently cited by MN OSHA. The 53 items were then assigned to one of three topic areas: *facility and equipment safety* (33 questions), *written safety documentation and records* (13 questions) and *personal protective equipment* (7 questions).

Activities and Resources: During the course of the study, owners and workers had access to the study website. The site provided free training for Right-to-Know, fire safety, and respirator use, safety program templates, medical evaluation for respirator users, hazard-specific checklists, and health and safety information related to collision repair. Respirator fit testing was provided by study staff upon the owner's request. Four safety newsletters were delivered by mail and posted on the website.

Aim 4

Based in the study results new opportunities were developed for ongoing cooperation with trade groups and Minnesota OSHA. Business owners' ability to correctly identify safety hazards was evaluated during a pilot study nested within the 1-year follow-up activities. [details in Bejan et al, 2013[50]]. The outcomes of this study were used to inform future interventions in technical school interventions for students entering the collision repair industry.

Nationally, technical vocational education plays a critical role in providing young workers with the skills required to obtain high-paying employment in competitive job markets[51]. The need for safety and health training during technical college education has been part of the NIOSH agenda since 1997.[52] However, our data indicate that technical education does not adequately prepare students to recognize and protect themselves from workplace hazards in either metal fabrication or auto collision repair businesses.[53] Upon graduation, most students in these trades will be employed in small establishments. With regard to health and safety, small enterprises are an underserved segment of the economy and a NIOSH NORA priority area.[54]

Results

Aim 1

Evaluation of select chemical and physical hazards was conducted in 6 facilities. The findings were published in two articles in Journal of Occupational and Environmental Hygiene.[45,56] Ergonomic evaluations were conducted in 2 facilities. Vibration was not found to be a major concern in these facilities. There are no tools in use in the shops whose duration or severity of vibration exposure would merit the use of antivibration gloves. The risk of hip and back stress is increased by the use of footwear with minimal ankle support. The risk of knee and back strain is increased by not using knee protection and lifting heavy items without assistance.

Aim 2

1. Two Advisory Boards were formed. Their input was essential in ensuring the accuracy and applicability of the study activities designed for owners and workers (e.g., surveys, training materials, safety checklists)
2. Six focus groups were held; three with workers and three with owners. The findings were published in the American Journal of Industrial Medicine.[46]
3. A detailed review of existing studies, work processes, protective equipment, and job hazards was conducted. The results were used to design the business evaluation form (survey). This survey evaluates multiple components of shop safety including electrical hazards, programs and policies, environmental problems, paint hazards, right-to-know policies and practices, respiratory protection programs and practices, personal protective equipment, fire safety, ergonomic problems, paint booth and mixing room function, and personal protective equipment use.
4. Surveys were developed to evaluate the health and safety practices of workers and owners in small collision repair shops and collect information on their perception of safety climate.
5. A study-specific website was developed: www.repairsafety.com has a public domain that contains safety information, and a password-protected section that was designed for study participants. All materials were created specifically for the collision repair industry and include safety programs, checklists, information about job hazards, personal protective equipment, and engineering controls. Links are provided to regulatory agencies that have standards applicable to this industry.

Aim 3

Study participants

Twenty six businesses were recruited randomly using letters and phone solicitations. Another 23 businesses were recruited through direct referrals. Baseline visits were conducted in 49 shops and 1-year follow-up visits were completed in 45 shops (92%). One business became ineligible during the study and three other declined to participate in follow-up. Year 2 follow-up visits were conducted in 33 businesses. All other owners declined participation.

Data analysis

As shown in Table 1, all shops participating in the intervention improved significantly in several health and safety areas, as measured by % items present in a specific survey section, a severity rating group and by category. [details in Parker et al, 2014[48]]

Table 1: Baseline and Follow-up Measures of Change in 45 Collision-Repair Shops

	Baseline		**Follow-up**		**Change**		
	Mean (%)	SD (%)	Mean (%)	SD (%)	Mean (%)	SD (%)	P
Overall	54	10	71	11	17	11	<0.0001
Survey section							
Shop safety and Right-to-Know training	38	17	68	23	30	24	<0.0001
Emergency planning, first aid, and fire prevention	60	12	73	11	13	12	<0.0001
Storage and use of compressed gases	81	27	81	29	0	37	0.99
Paint booth and mixing room	50	23	56	25	6	19	0.06
Ergonomics	64	16	73	11	9	17	0.0002
Electrical and machine safety and lockout/tagout	69	13	75	12	6	12	0.001
Personal protective equipment: ears, eyes, and skin	58	19	77	16	19	21	<0.0001
Respiratory protection	41	18	78	25	37	29	<0.0001

As shown in Table 2, all shops participating in the year 2 follow-up maintained the improvements made during the first year of the study. [details in Bejan et al, 2014[49]]

Table 2. Percent of items present at baseline, 1, and 2 year follow-up by survey section, health and safety topic and severity rating

	Baseline		1 year		2 years	
	Mean	SD	Mean	SD	Mean	SD
	% items present					
Overall	55	10	73[a]	11	73[b]	10
Survey section						
Safety in the shop and RtK training	40	18	70[a]	22	65[b]	19
Emergency planning, first aid and fire prevention	60	13	74[a]	12	74[b]	10
Compressed gases	81	27	81	28	89[b,c]	22
Paint booth and mixing room	50	23	60[a]	23	63[b]	23
Ergonomics	64	17	73[a]	10	74[b]	12
Electrical and machine safety and LOTO	70	14	76[a]	13	76[b]	11
PPE: ears, eyes and skin	60	21	78[a]	16	85[b,c]	14
Respiratory protection	43	18	81[a]	26	75[b,c]	22
Topic						
Facility and equipment safety	72	10	78[a]	10	79[b]	9
Written safety documentation and records	14	20	60[a]	28	56[b]	24
PPE	72	20	83[a]	14	89[b,c]	12

[a] significantly different from baseline ($p<0.05$)
[b] significantly different from baseline ($p<0.05$)
[c] significantly different from year 1 ($p<0.05$)

CARSS results indicate that when business owners received assistance with creating a Shop Improvement Plan, a greater percentage of recommendations listed in the plan were implemented both during study participation and over the subsequent year. We were unable to identify other studies in which this type of intervention (i.e., SIP) activity was tested. Quarterly reminder cards sent after the intervention period ended had no effect on the likelihood of owners requesting assistance with safety issues or the timing of the request if one was made.

Aim 4

Collision shop owners who had been previously exposed to safety information had difficulty in accurately assessing the state of safety and health in their businesses. While complete agreement between industrial hygienists' and owners' estimates was not anticipated, the nature of the safety items for which differences were observed, and the magnitude of these differences were surprising. Business owners were better able to identify the presence of written programs and policies than deficiencies in facility and equipment safety. [details in Bejan et al, 2013[50]].

A successful grant proposal was written in collaboration with two technical colleges in Minnesota: Hennepin Tech and St. Cloud Tech. This goal of this project is to evaluate the existing safety and health curricula in collision repair programs and use the resources developed during the CARS study to standardize and establish a comprehensive means of delivering this information to students.

Discussion

This section of the report will pertain primarily to **Aim 3**, Intervention implementation and evaluation. For detailed discussions of the results obtained for the other items please refer to the papers referenced above.

The CARSS intervention resulted in important changes, many of which were related to worker training and shop programs and policies. Consistent with our original hypothesis, a recommendation for improvement was more likely to be implemented if it was included in a formal SIP developed with the employer than if it were simply included in a report. Regular follow-up helped ensure that owners continued to work on their SIP. Online services most likely provided an important means of reaching both owners and workers—and thus increased the overall success of CARSS. Not surprisingly, improvements were greatest where CARSS was able to offer technical assistance such as respiratory protection, Right-to-Know training, and personal protective equipment for the ears, eyes, and skin. The smallest improvements were seen in areas related to electrical and machine safety and the paint booth and mixing room. Although several items worsened during the course of the intervention, none of these changes were statistically significant.

Based on two comparison samples, businesses enrolled in CARSS were similar to independent collision repair shops elsewhere in the nation. In a survey of 494 shops conducted by the Department of Labor in Washington State, the average shop had 7.2 employees and 25% of shops contracted with a safety professional.[56] In CARSS, the average shop also had 7.2 employees (SD= 4.8) and 24% of shops had engaged a safety consultant.

In an annual survey conducted by the trade journal *Body Shop Business*[57], the average collision shop in the United States had 8.8 employees (median =7). In the *Body Shop Business* survey, 68% of shops were independently owned and operated compared with 100% of the CARSS sample. However, participation in CARSS was limited to independently owned and operated establishments. Nationally, 36% of owners had graduated from high school compared with 32% of owners in CARSS. Nationally, 25% of owners had attended vocational school compared with 40% of owners participating in CARSS. Based on these data, it is likely that CARSS participants were similar to independently operated collision repair businesses elsewhere in the United States.

Intervention mapping provided a step-by-step framework for CARSS development, implementation, and evaluation. Intervention mapping was chosen for its applicability to different settings where there may be a wide range of needs and it is important to set site-specific performance objectives.[41,42,58] Developmental activities included advisory board meetings with AASP MN as well as suppliers, shop visits, focus groups, and pilot testing of all materials. In combination, these activities provided a perspective on the needs of owners and employees and helped ensure that services addressed serious hazards and regulatory deficiencies.[45-47]

Important barriers to improving health and safety in small enterprises that have been identified by other researchers were also identified by CARSS: (1) workers in small enterprises often believe they have the same responsibilities as owners, and (2) most collision shops lack a personnel infrastructure for managing health and safety.[46,59-61] CARSS materials were designed assuming that owners are responsible for ensuring shops have implemented effective health and safety programs. Materials were also designed to simplify and expedite the administrative aspects of managing health and safety programs.

Programs fostered changes by providing easy-to-use materials and bridging the relative isolation that makes collision shops hard to reach.[46,60,62] AASP MN played an important role in (1) helping assure the needs of its members were being met, (2) providing access to its advisory board and member shops, and (3) assisting with the recruitment of businesses. Sinclair et al.[63] labeled organizations such as AASP MN as "intermediary" and noted their important role in aligning the interests of their members with health and safety.

Even though necessary, owners chose not to make changes related to paint booth and mixing room and ergonomic hazards. The overall change in facility and equipment safety was only 6%. Among those who did select items in these two areas, little improvement was observed. This is not surprising because problems related to a paint booth and mixing room or other areas of the physical plant are often costly to repair and may entail a temporary cessation in shop operations. However, some situations that were highly dangerous did show substantial improvement, such as assuring there is a fire-extinguishing system in the paint booth, not locking emergency exits on the inside, and ensuring that electrical equipment is not used in wet areas unless GFCI outlets are present.

In addition, as most workers are required to provide many of their own tools, owners may not have been comfortable asking employees to make an investment in replacing their personal equipment and leave any possible changes up to workers. Owners' reluctance to mandate changes directly impacting workers has been observed elsewhere.[60,64]

Owners were reluctant to ask workers to take time away from production for safety and health training because it decreases shop income and may be perceived as unwelcome and paternalistic. Workers are frequently paid based on how many repairs they complete and are reluctant to take time for training for which they feel they are unfairly compensated[46]. Online training overcame this problem by allowing workers to complete mandatory training at a time they found convenient. Online medical certification allowed workers who use respirators to complete the OSHA-mandated medical evaluation without taking a half-day from work to do so.

Contrary to owner statements during CARSS focus groups, workers expressed a need for formal attention to health and safety.[46] The apparent *laissez faire* attitude toward safety and other aspects of human resources management by small business owners may be counterproductive. There is evidence that human resources programs and policies add to the likelihood of business success.[65-68]

Health and safety ought not be viewed as something that is simply present or absent in a small enterprise; rather it is part of a broad array of human resources management ranging from gender policies, health insurance, worker promotion, and sickness leave, to name a few. CARSS data show an absence of health and safety programs even when mandated by law. Although not specifically evaluated by CARSS, it is apparent that the lack of human resources infrastructure needs to be addressed if interventions in small enterprises are to be successful and sustainable.

From the vantage point of business development, formal human resources practices enhance employee perception of fairness and may lead to greater levels of employee commitment, especially in enterprises where employee satisfaction may be low.[69,70] Although large firms have formalized human resource practices, many small firms may lack the resources and technical knowledge necessary to develop and implement these practices.[71] As firms grow, there are pressures to formalize human resource management.[72]

From an enforcement perspective, regulations are often perplexing in their complexity and have the appearance of being expensive to implement. Addressing gaps in safety management systems was an essential component of CARSS. Relatively simple, cost-effective

options to reduce workers' risk and to enhance regulatory compliance were developed. Intervention programs were constructed around activities that have been associated with reduced injury rates and found to be acceptable to workers. This was accomplished by (1) assessing industry-wide injuries and hazards, and (2) qualitative evaluation of workers and owners perceptions of risks and perspectives on health and safety.[46,73]

Previous investigations in understanding and perception of safety and health hazards in collision repair shops show that owners are poorly informed about regulatory requirements as well as hazards and their health effects.[46,74] Misconceptions are likely fostered by the low likelihood of an injury in a business with only a few employees.[75] Even a dangerous establishment with 3 employees may go several years with no injuries. A typical of comment made by owners during the CARSS recruitment process was "they had never had an injury" and things were "fine as is."

In another large study of the collision repair industry, Enander et al.[76] describe the results of a state-wide, voluntary self-certification program for environmental compliance and health and safety. The study was carried out in 367 Rhode Island collision repair businesses of which 171 completed the self-certification forms. Technical assistance was provided regarding the interpretation of regulations, compliance methods, and engineering and pollution controls. The results indicate that medical evaluation for respirator users increased from 33% to 46%, the presence of a respiratory protection program increased from 33% to 61%, and PPE programs increased from 9% to 63%. These results are similar to those of CARSS, where the presence of easily implemented administrative and PPE programs showed significant improvement.

Shoemaker et al.[77] describe the results of the Boston Safe Shops Project. This was a collaborative effort between public institutions and collision repair shops. The intervention included shop assessment, employee and owner training, written information and hands-on assistance with improvements, and connecting people with local financial and health care resources. The Safe Shops Project showed significant improvement in regulatory compliance such as emissions control and worker training. As with CARSS, these changes were facilitated by both worker and owner training.

This study confirms the long-term success of CARSS, an intervention designed to deliver information through multiple channels and provide direct feedback to owners—the type of intervention found to be most effective by several research teams.[78-81] With the exception of a study conducted in the Iowa farming community that documented a continuous improvement in the identification and remediation of farm hazards over a 5-year period,[82] we were unable to identify worksite health and safety interventions (other than implementation of engineering controls) that involved an evaluation beyond the intervention period.

Most of the health and safety improvements accomplished during the first year of the CARS study were still in place at the end of a second year. Our data indicate that: (1) significant improvements continued to occur in two survey sections (*compressed gases* and *PPE: ears, eyes and skin*); (2) a significant decline was noted in *respiratory protection*; and (3) items that were selected for improvement at baseline and were not corrected at the end of year 1 were more likely to be found correct at the end of the year 2 when compared with items that were not selected for improvement at baseline.

Many items in facility and equipment safety were in good condition at baseline and were unlikely to show improvement over the course of the study. However, several items continued to show deficiencies and did not improve throughout the study. Although remediating some problems such as installing a ventilation system in the paint mixing room is costly, other

recommendations are easy and inexpensive to implement (e.g., using grounding and bonding wires correctly, installing illuminated exit signs).

The lack of shop-specific safety rules, inconsistent enforcement of rules, or lack of understanding regarding the regulatory requirements may be reasons why hazards such as blocked emergency exits and electrical panels were persistent. These factors add to the challenges presented by the limited size of the shop facility (including storage space) and a variable work load. For example, when a shop is busy, there may be numerous replacement parts received in a short time frame. These items must be temporarily stored before use. Constantly changing work volumes require the use of all available floor space, regardless of the possible safety issues/hazards that may arise.

The long-term improvements demonstrated in *written safety documentation and records* indicate that once the safety programs were created, they were likely to remain in place. On the other hand, when OSHA-mandated safety training was made available for free and via the internet, it often remained unused even when owners received reminders. Some of the barriers to the use of the web-based training may have been related to website set-up, which precluded owners from creating accounts and assigning training to their employees. Other challenges included a lack of electronic reminders for owners and workers, and limited computer access for employees.

In the year following the active intervention, only one owner created a written disciplinary policy to address employees' failure to follow safety rules, and less than a quarter of businesses had such a policy at the end of year 2. This is consistent with previous research that documents small business owners' ambivalence in establishing and enforcing a hierarchical relationship with employees. This is especially true in the absence of adverse events.[59,64,73,75,83,84]

The required use of *personal protective equipment* such as safety glasses, hearing protection, and respirators increased throughout the study. Owners were more likely to request that employees wear a respirator when spray painting than to wear hearing protection when operating compressed-air tools. A third of owners did not request that employees use safety glasses for operations that generate eye hazards, even though eye injuries are frequent in collision shops.[85] CARSS data are consistent with focus group findings that documented health hazard perceptions of collision shops owners, the majority of whom consider isocyanates the most important hazard in their business.[46]

CARSS results indicate that when business owners received assistance with creating a Shop Improvement Plan, a greater percentage of recommendations listed in the plan were implemented both during study participation and over the subsequent year. We were unable to identify other studies in which this type of intervention (i.e., SIP) activity was tested. Quarterly reminder cards sent after the intervention period ended had no effect on the likelihood of owners requesting assistance with safety issues or the timing of the request if one was made.

CARSS used a checklist as a means of evaluation. Steps were taken to ensure ongoing data quality over a prolonged period of time. We created documentation for each survey question, and a log was kept of evaluation decisions in order to assure consistent responses. Inter-rater reliability was assessed between study staff and external raters. Overall, the kappa statistic showed a high degree of concordance between raters.

The greatest limitation in this study is that participants were recruited by a variety of means, not entirely at random. This was necessary because of the difficulty encountered in recruiting an entirely random sample. Breslin et al.[78] identified only five high-quality randomized interventions targeting health and safety in businesses with fewer than 100

employees. Although randomization is often considered the "gold standard" for intervention studies[78,86], in reality this is not possible with small businesses.

True randomization is hindered because baseline data are needed to assess control shops. Once baseline data are obtained, we believe it is unethical to not provide this information to owners. Hence, there must be at least a minimum intervention[20]. Furthermore, owners are not interested in taking time to consider participation unless there is a clear benefit to their business.

In CARSS, no differences were seen between shops recruited at random and those recruited via other means. Nor were differences seen between shops recruited over the course of the intervention. It is unknown if there are characteristics of non-participants that make them substantively different from participants. When complete randomization was simulated at the end of the study, it was again found that neither order nor date of recruitment impacted outcome.

Another limitation is that intervention programs were directed towards owners as the primary agents of change. This is problematic because employees were not engaged in selecting items for the SIP. However, owners remain the gate keepers to small establishments.[75] While not engaging employees in decision-making processes is problematic, more problematic was owner nonparticipation which eliminates any possibility of outreach.

An important question remains as to the sustainability of our intervention programs. Preliminary data indicate that owners continue to use the CARSS materials. CARSS (www.repairsafety.com) is now providing free services to prior participants and very low cost services to other businesses.

CARSS data is strengthened by the high quality of data collection methodology and by the in-person verification of the presence and completeness of written records and inspection of equipment, personal protective equipment, and the shop facility.

Conclusions

Aim 1

Data suggest that solvent exposures for operations other than spray painting and paint gun cleaning are below current occupational exposure limits. Unlike previous studies, noise dosimetry did not identify personal exposures above the current regulatory limits. However, given the high noise levels recorded for many shop tools, it is possible that increased shop activity (production) would lead to overexposures. Collision repair technicians would benefit from receiving more information about ways to identify noisy tools, about hearing protectors and hearing loss. Personal dust sampling results indicate that respiratory protection would not be required during dust-generating tasks. Direct reading measurements showed that down-draft booths can be an effective method for controlling personal exposures to dust during sanding operations. User feedback on hearing protection devices indicates that models that have adjustable parts may be more comfortable and thus more likely to be used consistently. The results of this study are not representative of shops that perform high volume vehicle repair and painting or that work on large vehicles (fire trucks, buses, ambulances, etc.).

Aim 2

Although our focus groups were conducted in the collision repair industry, our findings point to important problems related to improving health and safety in very small business establishments in general. These include a lack of human resource management, the employer-employee relationship, the nature of the work contract (e.g., subcontract), and economic pressures from outside entities such as insurance companies. While it may be possible to motivate owners to undertake improvements in workplace safety in this industry, the formalized, time-intensive methods used in larger businesses are not likely to be successful. Owners brought forward ideas related to on-line, industry-specific information and services (e.g. training or medical surveillance programs, templates for written safety programs, fact sheets for selecting personal protective equipment). Clear and easy to use materials may convince owners that safety can be accomplished by undertaking small, relatively inexpensive improvements.

Aim 3

Simple, easy-to-use programs in combination with a small amount of input from CARSS industrial hygienists fostered significant changes in participating businesses. Programs were developed to bridge barriers to worker and owner participation. For workers, this entailed readily accessible training that did not remove them from work. For owners, it entailed easily implemented administrative options that did not detract from daily business operations.

The findings from CARSS and other small-business research[20,40,60,64,67] provide guidance on directions for future small business intervention programs:

- Programs should address the lack of personnel and administrative infrastructure. Health and safety are present as part of, or in addition to, other programs. Although most small businesses may lack safety and health programs, one underlying reason may be that they also lack other basic personnel programs and resources.
- Owners require constant reminders to complete basic programs. Even when resources were freely available, other factors, primarily lack of time, may prevent owners from implementing and maintaining safe work places.

- It is helpful to engage owners with assistance and support from industry groups. For CARSS, the AASP MN provided invaluable support in assuring its members that CARSS was a trusted partner.
- Owners have repeatedly mentioned that a lack of knowledge and time were the primary barriers to improving and maintaining health and safety conditions in their shops. Tailored information regarding hazards, solutions, and regulatory compliance, along with technical assistance, were available at no cost.

Providing owners with in-person evaluation visits, goal setting, and quarterly follow-up activities, newsletters, and web-based resources enabled the implementation of health and safety improvements. Most changes remained in place for an additional year after the intervention delivery ended. However, once the study staff-initiated activities ceased, improvements were more likely to continue if the deficiencies to be corrected had been included in a formal Shop Improvement Plan. We recommend that future interventions use the types of activities conducted during CARSS and place additional emphasis on increasing workers' awareness of safety hazards in the shop. We anticipate that greater improvements in workplace health and safety may occur, since collision repair employees believe that safety at work is a shared responsibility.[20]

Aim 4

Collision shop owners previously exposed to targeted safety information had some difficulty correctly identifying many unsafe/non-compliant items or situations in their facility. Relying only on the overall percentage agreement of answers between shop owners and an industrial hygienist fails to characterize the owners' ability to correctly identify the items in need of improvement. However, this ability is fundamental to improving workplace health and safety.

This pilot study allowed us to quantify the differences in safety assessments performed by business owners and an industrial hygienist, and identify safety issues that were not well understood by owners. Several means to improve the assessment instrument - such as using a consistent format of questions/answers and provide additional visual or written explanatory notes – were proposed. The development of easy to use self-assessment tools specific to different industries, in particular those with a large proportion of small businesses, may assist owners and workers with hazard remediation.

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Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: A Randomized Intervention in Collision Repair Shops

Total Enrollment: based on 54 businesses

Grant Number: R01 OH009086

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Females	Males	Sex/Gender Unknown or Not Reported	Total
Hispanic or Latino	1	3	1	5 **
Not Hispanic or Latino	6	241	1	248
Unknown (individuals not reporting ethnicity)	0	7	7	14
Ethnic Category: Total of All Subjects*	7	251	9	267 *
Racial Categories				
American Indian/Alaska Native	0	1	0	1
Asian	0	5	1	6
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	1	0	0
White	6	233	0	239
More Than One Race	0	0	0	0
Unknown or Not Reported	0	7	7	14
Racial Categories: Total of All Subjects*	7	251	9	267 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Sex/Gender Unknown or Not Reported	Total
American Indian or Alaska Native				
Asian				
Native Hawaiian or Other Pacific Islander				
Black or African American				
White	1	2	1	4
More Than One Race				
Unknown or Not Reported	0	1	0	1
Racial Categories: Total of Hispanics or Latinos**	1	3	1	5 **

* These totals must agree.
** These totals must agree.

Publications

Aim 1: Evaluate small (2-19 employees) collision repair shops for exposures to workplace hazards, the availability and use of engineering controls and personal protective equipment, and health and safety program management.

Bejan A, Brosseau LM, Parker DL. Exposure assessment in auto collision repair shops. J Occup Environ Hyg. 2011 Jul;8(7):401-8.

Bejan A, Brosseau LM, Parker DL. Supplemental Personal Noise exposure. J Occup Environ Hyg. 2011; 8; D73-4

Aim 2: Develop and pilot test intervention activities aimed at improving employee and owner health and safety in the auto collision repair industry.

Parker DL, Bejan A, Brosseau LM. A qualitative evaluation of owner and worker health and safety beliefs in small auto collision repair shops. Am J Ind Med. 2012 May;55(5):474-82.

Aim 3: Implement and assess the effectiveness of a peer-based intervention in improving health and safety practices and lowering exposures to physical and chemical hazards in auto collision repair shops.

Parker DL, Brosseau LM, Bejan A, Xi M. Understanding safety climate in small automobile collision repair shops. Am J Ind Med. 2014 Jan;57(1):78-86

Brosseau LM, Bejan A, Parker DL, Xi M, Skan M. Workplace Safety Programs, Practices and Conditions in Auto Collision Repair Businesses. J Occup Environ Hyg. 2014; 11:354-365

Parker DL, Bejan A, Brosseau LM, Skan M, Xi M. The Collision Auto Repair Safety Study (CARSS): A Health and Safety Intervention. Am J Ind Med. 2014 (e-published ahead of print DOI10.1002/ajim.22377)

Bejan A, Parker DL, Brosseau LM, Xi M, Skan M. Two-year Follow-up of the Collision Auto Repair Safety Study (CARSS). Ann Occ Hyg. 2014 (in review)

Aim 4: Develop guidelines for implementing health and safety interventions in this industry and disseminate these guidelines through the Alliance of Automotive Service Providers (AASP) and other trade groups.

Bejan A, Parker DL, Brosseau LM, Xi M, Skan M. A Comparison of Owner and Expert Evaluation of Health and Safety in Small Collision Repair Shops: A Pilot Study. Int'l J Occup Environ Hyg. 2013; 19(4):363-9

Bejan A, Skan M, Parker DL, Brosseau LM. Collision shops improve safety through CARSS. AASP News, May 2013

Bejan A, Skan M. Old CARSS, new CARSS - How a federally funded study created an affordable way to improve safety in YOUR business. AASP News, June 2013

Bejan A, Skan M, Parker DL, Brosseau LM. CARSS – a website that helps you comply with the MN OSHA Right-to-Know standard. AASP News, July 2013

Materials available for other investigators

Safety programs templates, checklists, information about hazards present in collision repair shops, personal protective equipment, engineering controls, and training modules are available on the study website. Some of these documents require a password-protected account. Please contact the Principal Investigator – Dr. David Parker at parked@parknicollet.com with requests for site access.