5-2013

The Negative Health Effects and Recommendations for the Reduction of Exposure to Toxic Substances in the Auto Body and Auto Repair Industry

Grace Barlet
University at Albany, State University of New York

The Negative Health Effects and Recommendations for the Reduction of Exposure to Toxic Substances in the Auto Body and Auto Repair Industry

Grace Barlet

The University at Albany, State University of New York

Honors Thesis

Research Advisor: Dr. David Carpenter

May 2013

Abstract

This paper will examine the negative health effects of exposure to hazardous and toxic substances used in the workplace of auto body and auto repair workers. These include volatile organic compounds found in paints and solvents (such as toluene, xylene, and isocyanates), as well as airborne particles released from sanding and grinding that may contain silica and heavy metals including lead, cadmium, and chromium. Workers need to be aware of how these substances can adversely affect their health, and what they can do to protect themselves since several of these chemicals have no established exposure limit. Employers must safeguard their employees' health by mandating that they wear the proper protective equipment, and oversight agencies must also ensure that employers are in compliance with regulations.

Acknowledgments

First and foremost, I would like to extend a very special thank you to Virginia St. Jean, whose passion for protecting the health of others was the true inspiration behind this paper. None of this would have been possible without her, and I am so grateful for everything that she taught me during my summer spent in San Francisco.

I would also like to thank my research advisor, Dr. David Carpenter, for his guidance throughout this entire process, and my family and friends, for all of the support and encouragement they gave me along the way.

Table of Contents

Introduction

The invention of the motor vehicle and subsequent development of the highway system following World War II dramatically transformed our way of life. It gave people the opportunity to use an automobile for pleasure as well as business, and allowed for the flexibility of travelling farther and faster than ever before. Along with their proliferation sprouted new forms of industry, including compulsory vehicle insurance, and businesses dedicated to their repair, maintenance, and customization. Today, there are thousands of small to medium sized shops that service vehicles all across the United States. These businesses typically conduct work that involves the use of highly toxic and hazardous materials such as paint and solvents (Environmental Protection Agency [EPA], 2011a). Because of the characteristically small size and limited resources of these auto body and auto repair shops, these hazardous substances can often be mishandled and improperly disposed of (Liu et al., 2006). As a result, controversy has arisen over the regulation of these businesses, which concerns not only the health of the surrounding environment, but the health and safety of the workers as well.

This paper will examine the negative health effects of exposure to hazardous and toxic substances used in the workplace by auto body and auto repair workers, in addition to current measures of protection that would reduce the dangers involved. These workers need to be aware of how these substances can adversely affect their health and what they can do to protect themselves, particularly since several of these chemicals have no established exposure limit.

Common Tasks and their Health Effects

An individual working in the auto body and auto repair industry performs a variety of tasks throughout their day, many of which involve them coming into contact - either directly or

indirectly - with harmful substances. These duties mainly include spray painting, sanding, welding, grinding, and cutting.

Auto body paint, along with primers, sealers, thinners, degreasers, and cleaners, are all categorized as organic solvents, which are used to dissolve substances that are insoluble in water. Organic solvents maintain paint in its liquid form. Once applied to a surface, however, they evaporate, allowing the paint to dry and form a coating (Centers for Disease Control and Prevention [CDC], 1987). When organic solvents evaporate, they release what are known as volatile organic compounds (VOCs) into the atmosphere. These chemicals are easily inhaled and have the potential to harm to our health. Acute effects include eye, nose, and throat irritation, headaches, nausea and vomiting, dizziness, and the worsening of asthma symptoms. Long-term exposure has been associated with damage to the central nervous system, liver and kidneys, as well as with an increased risk of cancer (CDC, 1987). To study the behavioral effects of exposure to organic solvents, Hänninen, Eskelinen, Husman, and Nurminen (1976) conducted a series of tests that found that, when compared to a non-exposed group, automotive painters demonstrated marked differences in psychological performance, which included impairments in memory and reduced emotional reactivity. However, these health effects will vary depending on several factors, including the nature of the chemical (since each differs in their degree to cause harm), the length of time an individual was exposed, and how much of the chemical they were exposed to (California Department of Public Health [CDPH], 2008).

When workers mix paint or spray on paint coatings, they are being exposed to these organic solvents. Paints contain a combination of many different chemicals, which can either be inhaled, as mentioned above, or absorbed through the skin when a person comes into direct contact with them (CDC, 1987).

Other harmful chemicals that workers are frequently exposed to are known collectively as isocyanates. Isocyanates are most commonly used in the production of polyurethanes, which are employed in the automotive industry because of their ability to create hard and durable coatings that are also weather-resistant. They are found primarily in hardeners, paints, primers, and sealers, and usually contain hexamethylene diisocyanate (HDI), isophorone diisocyanate (IPDI), or toluene diisocyanate (TDI). Therefore, workers can become exposed when performing tasks such as spray painting, mixing paint, or cleaning their spray guns. Breathing in the fumes of isocyanates, or even touching them, can irritate the respiratory tract and our skin, generating sensitization that can either lead to the development of asthma or trigger asthma attacks in people who already have the condition (EPA, 1997).

Toxic chemicals are not the only hazardous substances that auto body and auto repair workers are exposed to while in the workplace. Airborne particles that are produced from sanding, welding, grinding, and cutting, may contain silica and heavy metals like lead, cadmium, and chromium that can also harm our health. While dust mostly causes irritation to the eyes, throat, and skin, heavy metals have been shown to cause damage to the nervous system, lungs, kidneys, liver, and other organs (EPA, 2011b). Exposure to lead has been associated with a number of negative health effects, while cadmium and chromium have been linked to certain cancers. (EPA, n.d.; Agency for Toxic Substances and Disease Registry [ATSDR], 2012a; ATSDR, 2012b). These health effects will be explored in greater detail in subsequent paragraphs.

One of the main duties these workers perform is surface preparation. This primarily involves sanding, which is necessary in order to prepare a car for a new paint job since the surface must first be smoothed out to remove any imperfections. Filler, or bondo, may also be applied to fill voids. When a person is sanding, fine dust particles containing heavy metals and

abrasive silica are created that can easily be inhaled or ingested (The National Institute for Occupational Safety and Health [NIOSH], 1996a). What is more, this dust can easily stick to a worker's clothing and skin, and if not properly washed off, can spread around the shop and their home, exposing even more people to its harmful effects (EPA, 2011a). Most body fillers contain styrene, which has been linked to cancer at high exposure levels. Breathing it may also cause damage to the liver, as well as skin and respiratory irritation (ATSDR, 2012c). Some shops will also use a paint stripper known as methylene chloride. This has been linked to cancer, and can also cause irritation, drowsiness, and nausea (ATSDR, 2001a).

Tasks such as grinding, welding, and cutting, also create irritating dust. During the process of welding or cutting, some of the metal will become vaporized, condensing in the air to form small particles that can then be inhaled (Occupational Health and Safety Administration [OSHA], 2013). In addition, residue from old paint can end up in the air, which may contain traces of lead, chromium, cadmium, and other toxins that can cause significant damage to a person's health (EPA, 2011b). Another problem that workers can experience is referred to as welder's flash. It occurs when they are not wearing proper eye protection, and the retina of their eye is burned due to the ultraviolet light from the welding arc (NIOSH, 2010). .

Protective Measures

Shops should take the necessary steps to ensure that people working with and around hazardous substances or performing tasks that can cause injury are protected from harm by the best means possible. Individuals also need to be properly trained on how to use protective equipment, and be encouraged to use it whenever they are working.

One of the most effective ways for a worker in an auto body or auto repair shop to protect themselves is by wearing a respirator. The Occupational Safety and Health Administration (OSHA) requires by law that employers establish and implement a written Respiratory Protection Program when engineering controls meant to eliminate harmful substances in the air are not possible. The elements outlined in the program must be specific for the worksite and include procedures for how to select, use, and care for respirators, as well as employee medical evaluations, fit testing, and training (OSHA, 2000).

The two types of respirators that are most often used in these shops are a supplied-air respirator that provides clean air through a hose, and air-purifying respirators, which are fitted with a cartridge that filters out contaminants in the air. Dust masks are not a substitute for respirators. Since they do not fit as tightly on the face, dust masks do not offer the same kind of protection as a respirator would. Every respirator is designed for specific purpose or job, which makes one more suitable for a certain task over another. For example, a supplied-air respirator is preferred when spray painting, while air-purifying respirators fitted with organic vapor cartridges filter out solvents, and high efficiency particulate air (or HEPA) filters are ideal for removing dust when sanding (OSHA, 2002).

A vacuum sander is another piece of equipment that can significantly reduce exposure to harmful substances in the workplace. Essentially, it is a type of sander that has a vacuum hose attached to it. The head of the sander has holes in it for the intake of dust and debris while a person is sanding, and is designed with an exhaust system that gets rid of most of the dust in the air before it reaches the ground and spreads around the entire shop (NIOSH, 1996a). Although they can be more costly, vacuum sanders are a worthwhile investment for these shops. They are more cost effective in the long-term because they eliminate expensive repaints (dust that settles

on newly painted cars can ruin the paint job) and also extend sandpaper life. In addition, they shorten clean up time (EPA, 2011a). Although vacuum sanders will not be able to completely eliminate the dust in the air, they can pick it up much better than sweeping could, with the end result being a much cleaner - and healthier - shop.

After painting a vehicle, a worker must ensure that their spray gun is thoroughly cleaned to prevent contamination of the next paint job. To dissolve the leftover paint residue, solvents and thinners are typically used. Since these vapors can be inhaled or the skin can be exposed, individuals who perform this task and do not wear the proper protective equipment such as a respirator or gloves can be adversely affected. To reduce the possibility of exposure, automated or enclosed gun cleaning systems were developed that considerably decreased a person's contact with these solvents. Quite simply, a spray gun is placed in a closed container that automatically dispenses the cleaning solvent and eliminates the need to clean it manually. Some systems even recycle this solvent when finished so that it can be used again. However, this practice is not allowed in all states. Nevertheless, like vacuum sanders, an enclosed gun cleaning system can save businesses money in the long run because they cut down on the use of solvents and the amount of it that is wasted (EPA, 2011a; EPA, 2013a; Northeast Waste Management Officials' Association, 2007).

Perhaps most importantly, an auto body or auto repair shop must always be well ventilated. This ventilation system needs to be designed to draw vapors away from a worker's breathing zone. Some shops have ventilation systems with a hood that capture vapors and carry them to the outside through a duct. Others systems use fans to draw fumes away from the worker. Either way, they should be installed as close as possible to where the work is being performed (EPA, 2002). Spray painting especially should be done in a booth that is well

ventilated by a downdraft. This system is designed to allow air to enter through filters in the ceiling, pass over the parts of the car being painted, and exit - along with paint overspray and solvent fumes - through grates in the floor (NIOSH, 1996b). If proper ventilation is not possible in a shop, then respirators should always be worn while working.

Along with respirators, there are other items of personal protective equipment that should always be worn in the workplace. Eye protection, which includes goggles, safety glasses, and face shields, should be worn when grinding, welding, and sanding to ensure that dust, sparks, and other particles do not irritate or cause injury to the eyes. A worker may be unaware that while welding, a face shield and safety glasses should be worn, since a face shield alone will not adequately protect their eyes. There also needs to be a special filter in them to protect against the ultraviolet light from the welding arc that causes welder's flash, which can occur after they return home (NIOSH, 2010).

Gloves too should be worn, especially when spray painting, mixing paint, cleaning spray guns, or handling materials such as bondo. These gloves need to be resistant to the solvent or isocyanate a person is working with. Otherwise, the gloves will not be able to prevent these substances from passing right through them. Coming into contact with these chemicals can not only irritate the skin and cause an allergic reaction, but also cause harm to other parts of the body when they are absorbed. Nitrile gloves offer the best protection and will prevent contact with most solvents and isocyanates. However, gloves need to be replaced often because they will start to degrade and will not be resistant to these substances forever. Rubber gloves can also be worn to prevent dust from getting on hands while sanding and decrease the risk of it getting into food, the mouth, or anything else that an individual may touch afterwards (EPA, 2013b).

Wearing coveralls and a hood, or even long sleeves and long pants, will also protect workers from exposure to isocyanates, solvents, and dust (NIOSH, 1996c). However, one of the key aspects to preventing exposure and harm from these substances is for these workers to practice good hygiene. After sanding, for example, they must thoroughly wash their hands and face. They also need to keep their clothing clean, and make sure that it is removed in the workplace before leaving to go home. It should never be brought home with them because otherwise, all of their family members could be exposed to these harmful substances (EPA, 2011a; EPA, 2013a).

Potential Health Hazards of Commonly Used Substances

Almost every task performed by an auto body or auto repair worker exposes them to a number of different hazardous substances, including toxic chemicals and heavy metals. Although research pertaining to the health effects of some substances has been more extensive and conclusive than others, it appears that continuous exposure to any of these substances over an extended period of time - as so many of these workers often are - has the potential to significantly affect one's health (CDPH, 2008). Both OSHA and the National Institute for Occupational Safety and Health (NIOSH) have established legal limits on the maximum amount or concentration of a substance allowed in the air to try and protect workers (OSHA, 2006). However, these permissible exposure limits (as they are known as) can often be exceeded in the workplace (CDPH, 2008). The most common substances these workers encounter throughout their day, along with the health risks involved, are described below.

Toluene

Toluene is commonly used as a solvent and can be found in products such as activators and hardeners, clearcoats, thinners, and primers. Studies that have assessed the toxicity of this chemical generally indicate that short-term and long-term exposure to toluene can result in a number of negative health effects. The acute effects that have been observed include eye, skin, and respiratory irritation, and central nervous system depression, which can result in fatigue, nausea, headaches, and memory loss. In addition, individuals who are exposed to a large amount of toluene over a short period of time may experience cardiac arrhythmias and in the worst cases death. Long-term effects linked to high levels of toluene exposure include impairments in speech, hearing, and vision, and a decrease in mental ability. Damage to the liver, kidneys, and lungs has also been reported, along with developmental effects in children whose mothers were exposed to toluene during pregnancy. These include developmental delays, spontaneous abortions, minor facial and limb anomalies, and attention deficits (ATSDR, 2001a; EPA, 2012a).

The current OSHA criterion states that workers should not be exposed to more than 200 parts per million (ppm) of toluene over an eight hour workday. NIOSH, on the other hand, recommends that the permissible exposure limit be decreased to 100 ppm over an eight hour period (OSHA, 2012a).

Xylenes

Xylene is another solvent that can be found in thinners, basecoats, clearcoats, and primers. Although there are three forms of xylene, meta-xylene, ortho-xylene, and para-xylene, they have all been found to have similar effects on health. Short-term exposure can cause eye, skin, and respiratory irritation, gastrointestinal discomfort, difficulty breathing, and neurological

effects such as impaired memory and reaction time, dizziness, and changes in one's sense of balance. Death has been reported in individuals who were exposed to a high concentration of xylene over a short period of time. Chronic effects of xylene can result in harm to the liver, kidneys, lungs, and heart. Reproductive and developmental effects have also been observed, and may include spontaneous abortion, skeletal abnormalities, and low birth weight (ATSDR, 2007; EPA, 2007a). OSHA and NIOSH have both set the maximum amount of xylene allowed in the air during an eight hour workday to be 100 ppm (OSHA, 2012b).

Ethylbenzene

Ethylbenzene is primarily used in the production of styrene. It can also be used as a solvent in thinners, clearcoats, and primers. Among the effects that have been observed from the short-term exposure to high levels of ethylbenzene are eye, skin, and respiratory irritation, neurological effects such as dizziness, and central nervous system toxicity. Long-term exposure to ethylbenzene has been associated with hearing loss and damage to the blood, liver, and kidneys. Studies have reported developmental effects such as skeletal abnormalities in animals, but there is no clear evidence on how ethylbenzene affects fertility in humans. There has also not been conclusive evidence in regards to its ability to cause cancer. The International Agency for Research on Cancer (IARC) classifies ethylbenzene as a possible human carcinogen based on animal studies. However, the Environmental Protection Agency (EPA) has not yet determined it be a carcinogen (EPA, 2007b; ATSDR, 2010). The permissible exposure limit for ethylbenzene established by both OSHA and NIOSH is 100 ppm (OSHA, 2012c).

Methyl Ethyl Ketone

Methyl ethyl ketone, or 2-butanone (as it is sometimes referred to as) is a solvent found in clearcoats, thinners, primers, and basecoats. Studies have found that acute exposure to high concentrations of this chemical can cause eye, skin, and respiratory irritation, and central nervous system depression such as headaches and nausea. Although there is very limited information on the chronic health effects of methyl ethyl ketone in humans, studies have observed liver, kidney, and neurological damage in animals. There have also been reported developmental defects in the animals studied, including low birth weight. While it is not classified as a carcinogen, there is an inadequate amount of data available on its carcinogenicity (ATSDR, 1995; EPA, 2007c). The permissible exposure limit that has been established by OSHA and NIOSH for methyl ethyl ketone is 200 ppm (OSHA, 2012d).

Styrene

Styrene is found in bondo or body filler and can be highly toxic, especially if an individual is exposed to it at high concentrations. Short-term exposure can cause eye, skin, and respiratory irritation, as well as gastrointestinal effects. Chronic exposure can result in hearing loss, central nervous system depression, impaired reaction time and loss of memory, and kidney, liver, and blood damage. Although there have not been any reproductive or developmental effects reported from exposure to styrene, studies have suggested that it may be associated with an increased risk of cancer, and the IARC has classified it as a possible human carcinogen (EPA, 2007d, ATSDR, 2012c). OSHA established a permissible exposure limit of 100 ppm for styrene, while NIOSH set the limit much lower at 50 ppm (OSHA, 2012e).

Parachlorobenzotrifluoride

Parachlorobenzotrifluoride is a solvent that can be found in a number of different products, including cleaners and degreasers, thinners, clearcoats, activators and hardeners, and primers. Although this chemical is present in many products, there has been very limited research on its health effects. However, it has been shown to cause eye, skin, and respiratory irritation, liver and kidney damage, and central nervous system depression. Unlike the other chemicals mentioned above, there is no permissible exposure limit currently established by OSHA or NIOSH for this chemical (National Toxicology Program, 2009; Special Materials Company, 2011; United States National Library of Medicine, 2011).

Lead

Lead is a metal that has been well studied over the years because of its toxicity and ability to cause a number of adverse health effects. Auto body or auto repair workers can become exposed to lead when performing tasks such as sanding or grinding. Although the use of lead in automotive paint has now been considerably reduced or eliminated altogether, it can still be found in the paint on older vehicles. This exposure can result in an array of harmful outcomes, from nervous system and cardiovascular effects, to decreased kidney function, brain damage, reproductive problems such as miscarriage, and anemia. The short-term exposure to high concentrations of lead can even result in death. In children, the effects of lead poisoning are even more severe. Lead can cause a delay in growth and permanent damage to their brain and nervous system. As a consequence, these children have been shown to have difficulties with their behavior and ability to learn, a lower IQ, and hearing loss. This is why it is so critical for these workers to practice good hygiene techniques. Dust that contains lead can very easily spread

around the shop, exposing other individuals and their families to its toxic effects. Although there is no conclusive evidence that lead can cause cancer, studies do suggest that it is a possible carcinogen (EPA, n.d.; OSHA, 2012f).

The permissible exposure limit determined by both OSHA and NIOSH is no more than 0.05 milligrams per cubic meter (mg/m^3) of lead in the air over an eight hour period (OSHA, 2012g). However, this number may be exceeded in an auto body or auto repair shop. In a study to evaluate lead exposure among automotive repair technicians, researchers found that workers were often at risk of exposure to lead above the regulatory limits of OSHA and NIOSH, especially if there was an inadequate ventilation system in place or they did not use the proper protective equipment when sanding. They also found that sanding dust easily stuck to their hands, which was then ingested when they ate or drank something, or touched their mouth directly (Enander et al., 2004).

Chromium

Workers are usually exposed to the metal chromium through sanding, welding, or grinding of automotive paint and car parts. This metal is found in two forms, chromium (VI) and chromium (III). Chromium (VI) is considered to be more toxic than chromium (III). In the short-term, chromium (VI) can cause eye, skin, and respiratory irritation, as well as gastrointestinal effects that include vomiting and hemorrhage. Chronic exposure to this metal can be extremely toxic. In the long-term, it can result in damage to the respiratory tract, including decreased pulmonary function, perforations and ulcerations of the nasal septum, bronchitis and pneumonia. It can also have effects on the liver, kidneys, and immune system. Animal studies suggest that chromium (VI) has the potential to cause reproductive problems in humans, but there is no clear

evidence and data is limited. However, chromium (VI) has been found to be a carcinogen, increasing the risk of lung cancer for those exposed (EPA, 2007e; ATSDR, 2012b). The permissible exposure limit established by OSHA for chromium (VI) is 5 micrograms per cubic meter ($\mu g/m^3$), while NIOSH set a limit of 0.001 mg/m^3 (OSHA, 2012h).

Cadmium

Cadmium, like chromium, is a metal that can be found in car parts and automotive paint. In the short-term, exposure to cadmium will mainly effects the lungs, causing bronchial and pulmonary irritation, as well as gastrointestinal effects such as vomiting and diarrhea. Chronic effects include disease of the kidneys (which can lead to the formation of kidney stones), and damage to the lungs, blood, and bones. It is still unknown whether cadmium effects reproduction or development in humans, but animal studies indicate that it has potential to cause reduced sperm count, low birth weight, skeletal malformations, and impairments in neurological development. In addition, the IARC has determined cadmium to be a carcinogen, contributing specifically to the development of lung and prostate cancer in those chronically exposed (EPA, 2007f; ATSDR, 2012a). OSHA has set the permissible exposure limit for cadmium at 5 $\mu g/m^3$ (OSHA, 2012i).

Regulations and Oversight

OSHA and NIOSH are the primary federal agencies that deal with matters of occupational health and safety, which includes the automotive industry. The EPA also became involved because of the emission of volatile organic compounds (VOCs) into the ambient air.

As mentioned previously, OSHA has a Respiratory Protection Program that requires workers to use a respirator when engineering or administrative controls (using less toxic

materials, for example) in the shop are not feasible. A shop must also establish this program if airborne contaminants have been determined to be above the permissible exposure limit or when an employer requires their employees to use a respirator. Under this law, employers must ensure that respirators are used in the proper manner. This means that they must fit correctly, and employees need to be trained on the correct way to clean, maintain, inspect, and store them. Employees must also undergo a medical evaluation by a physician to determine their ability to perform the work as well as wear a respirator (OSHA, 2000).

The problem with this program is that even though a shop may be required to implement it, it does not necessarily mean they will abide by it, and lapses in safety practices often occur. Some employees find wearing a respirator while performing certain tasks to be uncomfortable, especially a supplied-air respirator (United States Department of Health and Human Services, 1993; Sparer et al., 2004; Liu et al., 2006; Chang, Chen, Cheng, Shih, & Mao, 2007). If an employer does not strictly enforce that their employees use a respirator, then these individuals are putting themselves at a greater risk for developing serious health problems.

Another program that OSHA requires employers to develop is a written Hazard Communication Program. The employer must list all of the hazards found at the worksite, how they will inform their workers about these hazards, and how they will work around them safely. Products must be clearly labeled identifying what it is and warning of any hazards associated with its use. In addition, workers must be taught how to use and obtain a material safety data sheet (MSDS), which tells you whether a product is hazardous and how to use it safely. A shop is required to have an MSDS for every hazardous substance they use, and workers need to know where they are located in the shop. Furthermore, an employee training program must be implemented. Workers need to be informed about the health hazards of the substances they are

working with, how to tell if they have been exposed, and what specific protective measures they should be using to reduce or prevent harmful exposure. They also need to know the personal protection equipment to use for each job and its limitations (OSHA, n.d.).

OSHA has been criticized over the years for their lack of oversight and enforcement of regulations in a number of different industries, but this is particularly true in regards to auto body and auto repair shops. Their researchers have not been able to keep pace with the testing for the noxious properties of new chemicals being developed. In addition, for some of these chemicals, OSHA either does not have a set exposure limit or has standards that are less strict than NIOSH. Although an overall lack of funding and resources is largely to blame, changes need to be made that ensure these workers are being adequately protected (Weil, 2003; Public Citizen's Congress Watch, 2011; Center for Progressive Reform, 2012). Employers need to be held accountable for their employees' failure to wear the proper protective equipment. It is their responsibility to educate their workers and ensure that they are protected from harm.

Laws Regulating Volatile Organic Compounds

The use of paint and solvents adds a significant amount of pollution to the air because of their contribution to the formation of ground-level ozone. As a result, the government decided that VOCs were to be regulated by the EPA (EPA, 2012b). With the amendment to the Clean Air Act of 1990, section 7408 and 7412, came the establishment of limits to the amount of VOCs that were allowed in certain products. Along with the federal standard, each state has the option of enacting more stringent laws (EPA, 2012c). California, for example, currently has the strictest emission standards in the United States, and even then, they vary based on what air quality district you live in (Adhesives.org, 2013).

Auto body paint and other products used by these businesses are all regulated under these VOC laws. These laws are intended not only to cut down on the amount of pollution in the air, but to help protect the health of people living in the surrounding neighborhood as well. However, a common misconception is that these lower VOC paints are less toxic and are therefore safer for people to use. Although some harmful chemicals are removed to make the paint less volatile, other chemicals are added in that can be just as dangerous (EPA, 2012b).

The EPA allows certain chemicals to be exempt from these VOC laws. Due to their lower reactivity in the atmosphere, they have determined that these chemicals do not significantly contribute to ozone levels. When a chemical is exempt from these laws, manufacturers are then allowed to add as much of it to their products as they want without it contributing to the total VOC limit for that particular product (EPA, 2009; South Coast Air Quality Management District, 2011).

These exemptions are concerning because some of the chemicals that have been excluded from these laws have not been well-studied for their human health effects. Such is the case with the previously described solvent known as parachlorobenzotrifluoride. Manufacturers have been adding this exempt solvent to a wide range of products sold in states such as California to replace the ones that were banned under the stricter VOC laws. The problem, however, is that parachlorobenzotrifluoride currently does not have an established permissible exposure limit by OSHA (Special Materials Company, 2011). Since there have only been a handful of studies done to evaluate this chemical, its health effects are still relatively unknown. As a result, workers do not know how much of this chemical they can be exposed to before it begins to cause them harm. They also do not know what safety equipment will adequately protect them when working with this solvent. The best form of protection for these workers would be to wear a supplied-air

respirator, but since this type of respirator is not often worn, workers are unknowingly being exposed to a potentially dangerous chemical (EPA, 2013c).

Paint is an essential part of the automotive industry, as it primarily acts as a corrosion barrier. As VOC laws change and become more stringent, manufacturers are challenged to develop products that meet these requirements while still maintaining quality. This also leads to complications in regards to the sale and marketing of these products, because some products are not allowed to be sold in certain states (EPA, 1998).

Water-based paints have been developed that eliminate the need for most solvents and dramatically reduce the amount of VOCs in paint. However, although they are being used now more than ever before, further development is required before they completely replace traditional solvent-based paints (EPA, 2008). In a study comparing water-based paint to solvent-based paint, researchers found that the water-based paint significantly cut down on workers' exposure to organic solvents, specifically to toluene. In fact, workers were three times more likely to be exposed to organic solvents when they used a solvent-based system versus a water-based system (Bråtveit, Hollund, & Moen, 2004). Waterborne paint can be deceiving, however, because of the idea that it eliminates the use of dangerous chemicals. This is not true, and protective equipment must still be worn. Another drawback with water-based paints is that they are more expensive than solvent-based paints (EPA, 2008; EPA, 2012d).

Although the regulation of VOCs has made a positive impact on the reduction of pollution levels, chemicals need to be properly tested before they are granted exemption from these laws. The government should also ensure that these chemicals have a permissible exposure

limit, so that individuals know how toxic the chemical is and what the best method of protection would be.

Conclusion

The concerns regarding the occupational safety of workers in auto body and auto repair shops are compounded because workers in this industry are simultaneously exposed to a number of toxic substances, even with the development of lower VOC products such as water-based paints. A key component in decreasing their exposure is awareness. Employers themselves need to be educated about the dangers of these substances so they can ensure their employees are being adequately protected. They must also do their part in encouraging their workers to wear the proper personal protective equipment and explain why it is vitally important for them to do so. However, there is no guarantee that a shop which has a Hazard Communication Program and Respirator Protection Program in place will adhere to it, especially if there is no oversight by OSHA.

Furthermore, chemicals should not be allowed to be exempt from VOC laws until they have been sufficiently tested for their health effects first. Otherwise, after a chemical is exempt, manufacturers can add it a wide range of products, while individuals are left unaware of the potential dangers involved. At the very least, OSHA should ensure that these chemicals have a permissible exposure limit.

Individuals have the right to know if a substance they are required to use in their workplace may be deleterious to their health so that they can take the necessary measures to adequately protect themselves. Not only would it improve their health status, but it would reduce the need for health care services for affected workers. It is in the best interest of all of us to

reduce the health risks associated with occupational hazards, as it will lower the health care costs for the entire population in the long-term.

References

Adhesives.org. (2013). *VOC Guide.* Retrieved from http://www.adhesives.org/resources/voc-guide

Agency for Toxic Substances and Disease Registry. (1995). *ToxFAQs for 2-Butanone*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=342&tid=60

Agency for Toxic Substances and Disease Registry. (2001a). *ToxFAQs for Methylene Chloride*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=233&tid=42

Agency for Toxic Substances and Disease Registry. (2001b). *ToxFAQs for Toluene*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=160&tid=29

Agency for Toxic Substances and Disease Registry. (2007). *ToxFAQs for Xylene*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=295&tid=53

Agency for Toxic Substances and Disease Registry. (2010). *ToxFAQs for Ethylbenzene*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=382&tid=66

Agency for Toxic Substances and Disease Registry. (2012a). *ToxFAQs for Cadmium*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=47&tid=15

Agency for Toxic Substances and Disease Registry. (2012b). *ToxFAQs for Chromium*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=61&tid=17

Agency for Toxic Substances and Disease Registry. (2012c). *ToxFAQs for Styrene*. Retrieved from http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=420&tid=74

Bråtveit, M., Hollund, B., & Moen, B. E. (2004). Reduced exposure to organic solvents by use of water-based paint systems in car repair shops. *International Archives of Occupational and Environmental Health*, *77*(1), 31-38.

California Department of Public Health. (2008). *Understanding Toxic Substances.* Retrieved from http://www.cdph.ca.gov/programs/hesis/Documents/introtoxsubstances.pdf

Centers for Disease Control and Prevention. (1987). *Organic Solvent Neurotoxicity*. Retrieved from http://www.cdc.gov/niosh/docs/87-104/

Center for Progressive Reform. (2012, July). *The Next OSHA: Progressive Reforms to Empower Workers.* Retrieved from http://www. progressivereform.org/articles/Next_Generation_ OSHA_1207.pdf

Chang, F., Chen, M., Cheng, S., Shih, T., & Mao, I. (2007). Evaluation of dermal absorption and protective effectiveness of respirators for xylene in spray painters. *International Archives of Occupational & Environmental Health*, *81*(2), 145-150.

Enander, R. T., Cohen, H. J., Gute, D. M., Brown, L. C., Desmaris, A. C., & Missaghian, R. (2004). Lead and Methylene Chloride Exposures Among Automotive Repair Technicians. *Journal of Occupational and Environmental Hygiene*, *1*(2), 119-125.

Environmental Protection Agency. (n.d.). *Learn about Lead*. Retrieved from http://www2.epa.gov/lead/learn-about-lead#effects

Environmental Protection Agency. (1997). *Isocyanates Profile: Autorefinishing Industry*. Retrieved from http://www.epa.gov/dfe/pubs/auto/profile/isocynates-revision4b1c.pdf

Environmental Protection Agency. (1998, August). *Volatile Organic Compound Emissions from Automobile Refinishing - Background Information for Promulgated Standards.* Research Triangle Park, NC: Office of Air Quality Planning and Standards. Retrieved from http://www.epa.gov/ttnatw01/183e/arc/fautobid.pdf

Environmental Protection Agency. (2002). *Breathing Easy: Ensuring Proper Ventilation of Paint Mixing Rooms in Auto Refinish Shops.* Retrieved from http://www.epa.gov/air/community/details/autobody_shops_addl_info.html

Environmental Protection Agency. (2007a). *Xylenes.* Retrieved from http://www.epa.gov/ttnatw01/hlthef/xylenes.html

Environmental Protection Agency. (2007b). *Ethylbenzene.* Retrieved from http://www.epa.gov/ttnatw01/hlthef/ethylben.html

Environmental Protection Agency. (2007c). *Methyl Ethyl Ketone (2-Butanone).* Retrieved from http://www.epa.gov/ttnatw01/hlthef/methylet.html

Environmental Protection Agency. (2007d). *Styrene.* Retrieved from http://www.epa.gov/ttn/atw/hlthef/styrene.html

Environmental Protection Agency. (2007e). *Chromium Compounds.* Retrieved from http://www.epa.gov/ttnatw01/hlthef/chromium.html

Environmental Protection Agency. (2007f). *Cadmium Compounds.* Retrieved from http://www.epa.gov/ttnatw01/hlthef/cadmium.html

Environmental Protection Agency. (2008).*Using Waterborne Basecoats in Collision Repair Shops: A Case Study.* Retrieved from http://www.epa.gov/dfe/pubs/auto/ bestpractices /waterborneCaseStudy.pdf

Environmental Protection Agency. (2009). *Definition of Volatile Organic Compounds (VOC).* Retrieved from http://www.epa.gov/ttn/naaqs/ozone/ozonetech/def_voc.htm

Environmental Protection Agency. (2011a). *Auto Body Shops.* Retrieved from http://www.epa.gov/oaqps001/community/details/autobody_shops.html#4

Environmental Protection Agency. (2011b). *Auto Body Shops - Additional Information.* Retrieved from http://www.epa.gov/air/community/details/ autobody_ shops _addl _info.html

Environmental Protection Agency. (2012a). *Toluene.* Retrieved from http://www.epa.gov/ ttnatw01/hlthef/toluene.html

Environmental Protection Agency. (2012b). *Volatile Organic Compounds.* Retrieved from http://epa.gov/air/caa/caa_history.html#caa90

Environmental Protection Agency. (2012c). *History of the Clean Air Act.* Retrieved from http://epa.gov/air/caa/caa_history.html#caa90

Environmental Protection Agency. (2012d). *Outdoor Air - Industry, Business, and Home: Painting and Coating Operations.* Retrieved from http://epa.gov/air/caa/caa_history. html#caa9

Environmental Protection Agency. (2013a). *Autobody Refinishing General Best Shop Practices*. Retrieved from http://www.epa.gov/dfe/pubs/auto/bestpractices/bestpr.pdf

Environmental Protection Agency. (2013b). *Choosing the Right Gloves for Painting Cars*. Retrieved from http://www.epa.gov/dfe/pubs/auto/gloves/index.htm

Environmental Protection Agency. (2013c). *Supplied Air Respirators in Automotive Shops: Get the Best Protection*. Retrieved from http://www.epa.gov/opptintr/ dfe/pubs/auto/ respirator/index.html

Hänninen, H., Eskelinen, L., Husman, K., & Nurminen, M. (1976). Behavioral effects of long-term exposure to a mixture of organic solvents. *Scandinavian Journal of Work, Environment & Health, 2*(4), 240-255.

Liu, Y., Stowe, M. H., Bello, D., Woskie, S. R., Sparer, J., Gore, R., & ... Redlich, C. A. (2006). Respiratory Protection from Isocyanate Exposure in the Autobody Repair and Refinishing Industry. *Journal of Occupational & Environmental Hygiene, 3*(5), 234-249.

National Institute for Occupational Safety and Health. (1996a). *Control of Dusts from Sanding in Autobody Repair Shops*. Retrieved from http://www.cdc.gov/niosh /docs/ hazardcontrol/hc1.html

National Institute for Occupational Safety and Health. (1996b). *Control of Paint Overspray in Autobody Repair Shops.* Retrieved from http://www.cdc.gov/niosh/docs/ hazardcontrol/ hc2.html

National Institute for Occupational Safety and Health. (1996c). *Preventing Asthma and Death from Diisocyanate Exposure DHHS.* Retrieved from http://www.cdc.gov/niosh/docs/96-111/

National Institute for Occupational Safety and Health. (2010). *Eye Safety.* Retrieved from http://www.cdc.gov/niosh/topics/eye/

National Toxicology Program. (2009, June). *Chemical Information Profile for 1-Chloro-4-(trifluoromethyl)benzene.* Retrieved from http://ntp.niehs.nih.gov/ntp/noms/support _docs/pcbtf060409.pdf

Northeast Waste Management Officials' Association. (2007). *Enclosed Spray Gun Washers Using Alternative Cleaner.* Retrieved from http://www.newmoa.org/prevention/p2tech/ altspraygunwash.pdf

Occupational Health and Safety Administration. (n.d.). *Hazard Communication.* Retrieved from http://www.osha.gov/dsg/hazcom/index.html

Occupational Health and Safety Administration. (2000). *Respiratory Protection Program Guidelines.* Retrieved from http://www.osha.gov/pls/oshaweb/owadisp.show_document? p_table=DIRECTIVES&p_id=2125

Occupational Health and Safety Administration. (2002). *Respiratory Protection.* Retrieved from http://www.osha.gov/Publications/OSHA3079/osha3079.html

Occupational Health and Safety Administration. (2006). *Permissible Exposure Limits (PELs).* Retrieved from http://www.osha.gov/dsg/topics/pel/index.html

Occupational Health and Safety Administration. (2012a). *Chemical Sampling Information: Toluene.* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/CH_272200 .html

Occupational Health and Safety Administration. (2012b). *Chemical Sampling Information: Xylene.* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/CH_276400 .html

Occupational Health and Safety Administration. (2012c). *Chemical Sampling Information: Ethylbenzene.* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/ CH_240000.html

Occupational Health and Safety Administration. (2012d). *Chemical Sampling Information: 2-Butanone.* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/CH_222300.html

Occupational Health and Safety Administration. (2012e). *Chemical Sampling Information: Styrene.* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/CH_268200.html

Occupational Health and Safety Administration. (2012f). *Lead.* Retrieved from http://www.osha.gov/SLTC/lead/

Occupational Health and Safety Administration. (2012g). *Chemical Sampling Information: Lead.* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/CH_249110.html

Occupational Health and Safety Administration. (2012h). *Chemical Sampling Information: Chromium (VI).* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/CH_228697.html

Occupational Health and Safety Administration. (2012i). *Chemical Sampling Information: Cadmium.* Retrieved from http://www.osha.gov/dts/chemicalsampling/data/CH_223897.html

Occupational Health and Safety Administration. (2013). *Controlling Hazardous Fume and Gases During Welding.* Retrieved from http://www.osha.gov/Publications/OSHA_FS-3647_Welding.pdf

Public Citizen's Congress Watch. (2011, October). *OSHA Inaction.* Washington, DC: Justin Feldman. Retrieved from http://www.citizen.org/ documents/osha-inaction.pdf

South Coast Air Quality Management District. (2011). *Exempt Compounds*. Retrieved from http://www.aqmd.gov/prdas/coatings/VOCs/vocsExempts.htm

Sparer, J., Stowe, M. H., Bello, D., Youcheng, L., Gore, R. J., Youngs, F., & ... Woskie, S. R. (2004). Isocyanate Exposures in Autobody Shop Work: The SPRAY Study. *Journal of Occupational and Environmental Hygiene*, *1*(9), 570-581.

Special Materials Company. (2011). *PCBTF MSDS.* Retrieved from http://www.pcbtf.com/pcbtf_parachlorobenzotrifluoride_msds.html

United States Department of Health and Human Services. (1993, May). *In-depth Survey Report: Control Technology for Autobody Repair and Painting Shops* (Report No. ECTB 179-14a). Cincinnati, Ohio: National Institute for Occupational Safety and Health. Retrieved from http://www.osha.gov/SLTC/autobody/docs/ectb179-14a/ectb179-14a.html

United States National Library of Medicine. (2011). *1-Chloro-4-(trifluoromethyl)benzene*. Retrieved from http://toxnet.nlm.nih.gov/cgi-bin/sis/search

Weil, David. (2003, January). *OSHA: Beyond the Politics*. Retrieved from http://www.pbs.org/wgbh/pages/frontline/shows/workplace/osha/weil.html