

# A National Survey of Health and Safety Knowledge and Beliefs Among Technical Vocational Faculty in Autobody Collision Repair Technology

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**Objectives:** Career technical education (CTE) programs prepare new generations of technicians in a variety of trades. Even though occupational safety and health (OSH) ought to be included as an essential part of CTE curricula it is frequently absent or inadequately taught. **Methods:** OSH knowledge and beliefs were assessed in a national sample of 125 secondary and post-secondary faculty in autobody collision repair technology. **Results:** Over 50% of faculty thought at least 75% of OSH knowledge was learned at school, and 9% felt that safety was primarily learned on the job. Knowledge scores ranged from 22% to 78%. Overall knowledge scores were significantly lower among high school than among post-secondary instructors (42% vs 50%,  $P \leq 0.001$ ) and in two categories: hazard recognition (44% vs 54%,  $P \leq 0.05$ ) and hazard control and shop equipment (30% vs 37%,  $P \leq 0.05$ ). **Conclusions:** There are substantial gaps in OSH knowledge among secondary and post-secondary CTE instructors. CTE programs should address these gaps by providing trade-specific safety and health education to their instructors upon hiring.

**Keywords:** career education, curriculum, small business, vocational education, young workers

Nationwide, autobody collision technology (ABCT) employs approximately 187,000 workers in 41,000 businesses.<sup>1</sup> Of these, 38%, 31%, and 23% work in establishments with less than 10, 10 to 19, and 20 to 49 employees respectively.<sup>2</sup> Most shops (60%) hired a new technician within the preceding 12 months, and 38% of employers reported that technical school was the primary means of recruiting new workers.<sup>1</sup> Data were not available on the age distribution of students in ABCT programs. However, the majority of students (79%) in career and technical education (CTE) programs were less than 25 years of age.<sup>3</sup> This age group has a rate of work-related injury that is 1.6 greater than that of older adult workers.<sup>4</sup>

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Clinical significance: Young workers are at increased risk of injury when compared with their older peers. Technical vocational education offers a strong opportunity to train new workers in health safety. However, there is a lack of knowledge among faculty at both the secondary and post-secondary levels.

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Survey data from 191 collision repair technicians show that unsafe work practices are highly prevalent. For example, 37% of workers did not use eye protection when grinding, 45% cleaned their hands with solvents, 15% did not use gloves when spray painting, and 50% were not clean shaven when wearing their respirator.<sup>5</sup> Surprisingly, there were no significant differences in health and safety knowledge, skills, or practices between CTE program graduates and their peers without vocational education. These findings are of concern because exposure to hazards encountered in collision repair facilities have well-known health effects. Adverse work conditions and practices are reflected in a 9-fold increase in the prevalence of asthma among employees in this industry when compared with workers in other industries.<sup>6</sup>

As previously summarized, in 2018, “nearly 20 million students were enrolled in postsecondary CTE in the United States.”<sup>7</sup> Of these, about 13.3 million were attending four-year institutions, and 6.7 million were attending two-year institutions of which 6.3 million were in public institutions.<sup>7,8</sup> As of 2015, 64% of credentials were awarded by 2-year public institutions such as technical and vocational colleges.<sup>9</sup> The number of sub-baccalaureate occupational credentials awarded increased by 44% between 2003 and 2015 from 1.01 to 1.46 million. Because of the large number of students in CTE programs, they play a crucial role in preparing workers for skilled jobs.<sup>9,10</sup>

Increased participation in CTE stems from increasing college costs, questioning of the utility of 4-year degrees by many students, and the realization that technical trades often lead to well-paid careers and employment opportunities. For example, overall, 86% of students with a credential in an occupational field were employed in 2009 compared with 82% of students with a credential in an academic field, and 74% were employed in their chosen field compared with 54% of those with an academic credential.<sup>11</sup> In addition, the de-stigmatization of CTE (once devalued as “shop class”) has led to its becoming a respectable path towards a skilled career.<sup>12,13</sup>

CTE programs support high school and postsecondary students in gaining the academic, technical, and employability skills necessary to pursue entry-level employment or advanced workforce training. CTE students acquire trade-specific knowledge, skills, and other competencies through classroom instruction and hands-on practice in workshops and laboratories where they are introduced to the tools, concepts, and principles of their trade and develop new skills by performing supervised tasks.<sup>14</sup> A competency is defined as the ability to apply a set of related knowledge, skills, and abilities in order to successfully perform functions or tasks in a defined work setting and are considered an important predictor of employment success.<sup>15,16</sup>

CTE differs from registered apprenticeship (RAs) programs as the later are typically high school programs designed to provide advanced skills and are sponsored by employers, employer associations, or trade unions. RAs have five key components: employer involvement, structured on-the-job training, related technical instruction, paid work instruction, and alignment with an industry recognized credential. However, an estimated one-third of individuals in RA programs are concurrently enrolled in a community or

technical college and, upon completion of their training, are awarded an associate degree.<sup>11</sup>

With regard to teaching occupational safety and health (OSH), faculty typically rely on their own experience, lack formal training and materials with which to teach, and are not provided opportunities in which to increase their OSH-related knowledge.<sup>17,18</sup> Several studies have identified gaps in health and safety knowledge and work practices of vocational students in the United States<sup>19,20</sup> and abroad.<sup>21,22</sup> When properly implemented, educational interventions designed with input from college instructors and specialized health and safety personnel have successfully increased students' knowledge of OSH and improved work practices.<sup>20</sup>

OSH ought to be included as an essential part of CTE programs. The incorporation of OSH into core competencies helps ensure that all individuals have a strong OSH foundation before entering into the workforce.<sup>4,14,23,24</sup>

The National Institute for Occupational Safety and Health (NIOSH) and the European Agency for Safety and Health at Work have led efforts to mainstream OSH into schools.<sup>24</sup> Schulte et al<sup>25</sup> reviewed national initiatives designed to ensure that vocational educational programs integrate OSH into training programs. These authors concluded there is little data on the extent of OSH training provided within CTE programs.

Previous research has explored secondary school CTE teachers' knowledge about, attitudes towards, self-efficacy, and intention to teach foundational competencies related to workplace safety and health.<sup>26</sup> These competencies are cross cutting, serve as the basis for advanced skill development, and are not specific to any one industry sector.<sup>27</sup> Apart from construction, we know of no evaluation that has been conducted on OSH training in CTE programs specific to various trades or industries.

After graduation, approximately 70% ABCT workers will be employed in small enterprises where they are unlikely to receive OSH training on the job.<sup>5,28</sup> Hence, vocational instructors play an important role in preparing new generations of workers. However, little is known about what, how, when, or if OSH is taught and if the teaching that takes place is effective and results in better work practices.<sup>17,29,30</sup>

Technical Education Curricula for Health and Safety (TECHS) is a multi-part research program to develop and assess postsecondary OSH training in ABCT and machine tool technology (MTT). To help fill this gap, this paper describes the findings of a national survey of health and safety knowledge among faculty teaching ABCT at the secondary and postsecondary levels.

## MATERIALS AND METHODS

All methods and materials were approved by the HealthPartners Institute, Institutional Review Board.

### TECHS Curricula

TECHS curricula were developed in conjunction with faculty at three Minnesota vocational technical colleges in order to facilitate the teaching of OSH in autobody collisions technology (ABCT) and machine tool technology. Details related to curricula development are summarized elsewhere.<sup>18</sup> Materials are available on the study website at: [www.votechsafety.net](http://www.votechsafety.net). For ABCT, there are nine modules, refresher modules, student tests, and lab activities. Materials include knowledge and skills questions pertaining to the fundamental OSH concepts covered within each topic-specific module: isocyanates, respirators, solvents, acids and bases, dusts and fumes, electrical safety, fire safety, eye protection, and hearing protection.

### Survey Development

The current study used a 56-item survey created by the two industrial hygienists and occupational physician that developed the TECHS ABCT curriculum and had previously conducted detailed

OSH assessment of autobody collision shops.<sup>18,31,32</sup> Of the 56 items, 22 elicited information about instructors' safety-related attitudes, beliefs, skills, and demographic information (eg, age, work experience). Thirty-four items assessed knowledge about health and safety concepts related to acids and bases, dusts and fumes, electrical hazards, eye and hearing protection, fire protection, isocyanates, respirators, and solvents. All knowledge questions were pilot tested with three to six instructors who provided feedback about question clarity, wording, and response choices. Prior to dissemination, the survey was reviewed by two collision repair instructors for content, response format, time for completion, and clarity.

### Data Collection

Data were collected via email by the Collision Repair Education Foundation (CREF), a nonprofit organization that works closely with vocational institutions to ensure programs have the equipment and materials needed to train ABCT workers. Data collection occurred over a 4-week period in July and August of 2019. Four hundred and six (406) instructors teaching in vocational colleges and high schools across the country were invited to participate. CREF assigned a unique ID to each respondent and forwarded de-identified responses to TECHS staff for analysis. The survey was closed after receiving 125 responses. All respondents received a \$20 gift card.

### Analysis

Individual knowledge scores were calculated based on the number of OSH questions answered correctly and were expressed in percentiles. If a question had a single correct answer, the response was coded 0 (incorrect) or 1 (correct). If a question had multiple correct responses, each response was assigned partial credit. For example, if a question had three correct answers, each correct answer received 0.33 points. Written responses to knowledge questions were analyzed in two steps. First, each response was given a score of 0 or 1 reflecting whether it was incorrect or correct. Next, incorrect responses were assigned to one of the following categories: (a) answer in the ballpark but incomplete or vague, (b) answer unrelated to the question, and (c) respondent noted they did not know. Knowledge questions were assigned to categories that matched the structure of the TECHS modules: (1) hazard recognition, (2) health effects, (3) hazard control and shop equipment, (4) personal protective equipment, and, (5) medical services and worker training. Scores for each topic could range from 0% (no correct answers) to 100%.

The survey was completed by instructors teaching only at the high school level, only in college, or in both high school and college. For each group, knowledge scores were summarized using mean, standard deviation, and range. Normality of knowledge scores was assessed and differences between groups were evaluated using a two-sample *t* test or equivalent Mann-Whitney *U* test if data were not normally distributed. Univariate regression was used to evaluate the association between knowledge scores and factors such as years of teaching (less than 1, 1 to 5, 6 to 15, and more than 15), years of experience in collision repair prior to teaching (less than 1, 1 to 5, 6 to 15, and more than 15), and previous role as an ABCT business owner or manager (yes or no). Statistical analyses were conducted using SAS (version 9.4, SAS Institute Inc., Cary, NC).

### Demographics

Surveys were completed by 125 instructors from 36 states. Of these 125 instructors, 20% taught only in high school, 55% in colleges, and 25% in both high school and college. The largest numbers of responses were from Texas and California with nine and eight participants respectively. As seen in Table 1, nearly all respondents were men, and 44% were between 55 and 64 years

**TABLE 1.** Instructor Demographics

	Post-Secondary		Secondary	All (N = 125) % Total
	College (N = 69) % Total	Mixed (N = 31) % Total	High School (N = 25) % Total	
Gender				
Male	99	94	100	98
Female	1	6	0	2
Age				
25–34	6	10	8	7
35–44	13	16	20	15
45–54	33	26	36	32
55–64	45	48	36	44
65 or older	3	0	0	2
Working in collision repair at this time?				
No	62	58	68	62
Yes, part-time	38	39	32	37
Yes, full-time	0	3	0	1
Years worked in collision repair before started teaching				
<1 yr	0	0	4	1
1–5 yrs	14	6	4	10
6–15 yrs	39	32	40	38
>15 yrs	46	61	52	51
Have you ever been a shop owner or manager?				
Yes	64	55	60	61
No	36	45	40	39
Years of teaching collision repair to students				
<5 yrs	22	19	20	21
6–15 yrs	37	39	36	37
>15 yrs	41	42	44	42
Years of teaching at the current school				
<5 yrs	28	31	50	31
6–15 yrs	34	38	29	35
>15 yrs	38	31	21	34
Education*				
AAS or Diploma in collision repair	67	45	40	56
Vocational certificate in collision repair	28	55	72	43
2 or 4 years degree not in collision repair	22	13	8	17
2 or 4 years degree in teaching or adult education	17	13	12	15
Certificate in teaching or adult education	20	45	20	26

\*Some respondents have more than one degree or certificate. Percentages do not add to 100%.

old. For respondents with only one degree or certificate, 33% had an associate degree or diploma in collision repair, 17% had a vocational certificate in a trade other than ABCT, and 14% had a 2- or 4-year degree or certificate in teaching or adult education. The remaining 45 (36%) of individuals had two or more degrees or certificates. The majority of instructors (89%) had worked in collision repair for 6 or more years before teaching, and 61% had been shop owners or managers. Nearly 40% of the instructors were still working part time in collision repair.

## RESULTS

### Instructor Beliefs

With regard to learning about OSH, just over 50% of faculty thought 75% or more knowledge was learned at school and not on the job, and 9% felt that safety was primarily learned on the job. Eighty-five percent (85%) of instructors were satisfied with the amount of time they spent teaching OSH. The other 15% (N = 19) of respondents did not spend enough time teaching OSH and cited reasons such as the large amount of technical material that must be covered, a short academic year, and students thinking safety is boring. Only one instructor felt he did not have the necessary expertise to teach OSH. The majority of respondents rated their

teaching skills as good (29%), very good (45%), or excellent (25%) for both classroom and lab instruction (data not shown in tables).

The majority of instructors (64%) believed that OSH-related responsibility in shops is equally shared by workers and business owners. Surprisingly, 13% of instructors believed that OSH is 75% workers' responsibility, and 6% of instructors believed that workers are 100% responsible. Nearly all respondents (82%) believed that managements' commitment to safety is either very important or critical in preventing injuries in collision shops. Eleven respondents (9%) believed that 100% of the safety problems can be identified and corrected before an accident occurs.

With regard to OSH-related issues at their school, most faculty (86%) were comfortable reporting safety problems to their school's administration. The remainder were either minimally comfortable or uncomfortable doing so. Just over 10% of faculty members were not comfortable disciplining a student for infractions of safety rules.

### Safety and Health Knowledge

Overall knowledge scores ranged from 22% to 78%. As seen in Table 2, years of teaching, years of working in collision repair, or having been a shop owner or manager did not have a significant impact on instructor knowledge of OSH. Respondents with an

**TABLE 2.** Knowledge Score Comparison by Select Demographic Variables

	N	Mean (SD)	Range	P Value
Years of teaching				
≤5	26	47 (8)	28–62	0.65
6–15	47	49 (11)	22–78	
≥16	52	48 (11)	24–71	
Years of working in collision repair before teaching				
≤5	14	51 (8)	37–64	0.29
6–15	47	48 (10)	26–70	
≥16	64	48 (11)	22–78	
Business owner or manager				
Yes	76	48 (11)	24–78	0.96
No	49	48 (10)	22–64	
Education				
AAS/Diploma in ABCT	70	50 (10)	26–78	≤.05
Other education	55	46 (11)	22–71	

Associate of Applied Science (AAS) degree or a diploma in collision repair had slightly but significantly higher scores than their peers (50% vs 46%,  $P=0.03$ ). This relationship did not change with the number of degrees held. A weak positive association ( $P=0.05$ ) was seen between knowledge scores and instructors' perceptions of the percentage of safety issues that can be identified and corrected before an injury occurs (data not shown). There was no association between overall knowledge and the instructors having been an owner or manager or the number of years they had taught.

Knowledge scores were not significantly different between instructors who taught in college and instructors who taught in both college and high school. These groups were combined for subsequent analyses and are referred to as postsecondary instructors. Postsecondary instructors' survey responses are compared with those of the instructors teaching only in high schools (secondary instructors).

As seen in Table 3, high school instructors' overall knowledge scores were significantly lower among high school than among post-secondary instructors (42% vs 50%,  $P\leq 0.001$ ). Their scores were also lower in two categories: hazard recognition (44% vs 54%,  $P\leq 0.05$ ) and hazard control and shop equipment (30% vs 37%,  $P\leq 0.05$ ). The score differences between the two groups approached statistical significance (59% vs 69%,  $P=0.06$ ) for the personal protective equipment category. Some respondents in both groups correctly answered all questions related to medical

services and training and personal protective equipment. However, the highest scores in the remaining categories were 85% (hazard recognition by postsecondary instructors) and 73% (health effects by secondary instructors). Two instructors did not correctly answer any questions in the health effects category, and one instructor did not correctly answer any questions in the personal protective equipment category.

Table 4 gives examples of important OSH issues that were problematic for many instructors as well as an explanation related to each question. Only 39% of postsecondary instructors and 44% of the secondary instructors knew that skin contact with isocyanates may occur during removal of masking tape, a frequent task performed by collision repair technicians. Over half of postsecondary instructors (55%) and 68% of secondary instructors knew that an emergency eye-wash station cannot consist of two hand-held bottles of saline solution rather than a station which provides continuous flow for 15 minutes. Other important differences in scores found between postsecondary and secondary instructors respectively included: the need to bond two containers before transferring flammable liquids (17% and 8%); the need to place grounding clamps on a bare metal surface (44% and 28%); understanding that safety glasses do not protect against chemical splashes (70% and 76%); and, that medical evaluation for respirator users must be administered during regular working hours (55% and 60%).

Five questions related to hazard recognition, health effects, shop equipment, and personal protective equipment required written answers. In addition to correct or incorrect answers, we identified incomplete or vague answers that were labeled "in the ballpark" or answers unrelated to the question (Table 5).

An acid or base that may damage the skin was correctly identified as a corrosive by 30% and 35% of postsecondary and secondary faculty respectively. Amperage was correctly identified as the most important characteristic of an electrical current contributing to adverse health effects of electrocution by 41% and 16% of postsecondary and secondary respondents. Twenty-two percent (22%) of postsecondary and 32% of secondary instructors gave an answer scored as "unrelated" to the question that asked what characteristic makes an electrical current hazardous.

Only 18% of postsecondary and 20% of secondary instructors identified asthma as the primary health problem caused by isocyanates. An additional 33% and 24% respectively gave related, albeit incomplete or imprecise, answers such as "breathing problems." Incorrect responses included health effects such as nerve and liver damage, cancer, or hardening of the arteries.

Few instructors at the postsecondary (17%) and secondary (28%) levels correctly identified the need to limit the pressure in compressed air guns to less than 30 pounds per square inch (PSI).

**TABLE 3.** Instructors' Knowledge Scores by Category and Institution

Category (Number of Questions)	Post-Secondary (N = 100)	Secondary (N = 25)	P Values
	Mean (SD) {range}	Mean (SD) {range}	
All questions	50 (10) {26–78}	42 (9) {22–56}	≤0.001
Hazard recognition (12 <sup>*</sup> )	54 (15) {15–85}	44 (14) {13–67}	≤0.05
Health effects (5 <sup>†</sup> )	42 (18) {0–80}	37 (17) {0–73}	0.27
Hazard control and shop equipment (10 <sup>‡</sup> )	37 (11) {15–67}	30 (11) {5–48}	≤0.01
Personal protective equipment (4 <sup>§</sup> )	69 (24) {0–100}	59 (23) {25–100}	0.06
Training and respirator clearance (3 <sup>  </sup> )	64 (19) {17–100}	62 (18) {25–100}	0.63

\*Question count by topic: isocyanates [2], solvents [1], acids and bases [2], dust and fumes [2], electrical safety [3], fire safety [2].

†Question count by topic: isocyanates [2], solvents [1], hearing protection [2].

‡Question count by topic: respirators [2], acids and bases [1], electrical safety [3], fire safety [3], other [1].

§Question count by topic: respirators [2], eye protection [2].

||Question count by topic: respirators [2], fire safety [1].

**TABLE 4.** Examples of Health or Safety Items With Low Percentage of Correct Answers

Category	% Correct Answers Post-secondary/Secondary	Health or Safety Item
Hazard recognition	39/44	Workers come into contact with isocyanates when removing masking tape.
	Explanation: Recently painted cars may be an important route of sensitization and may contribute to the development of isocyanate-induced asthma. Any process that exposes a worker to fresh paint is potential source of exposure. <sup>33</sup> 17/8	Bonding two containers before transferring flammable liquids prevents sparks.
Health effects	44/28	Only clamps placed on bare metal reduce static electricity build-up when transferring flammable liquids between two containers.
	Explanation: Grounding clamps must be attached to a bare metal surface, not over paint. This prevents static charge between two containers and sparks causing an explosion. <sup>34</sup> 27/32	Once you have hearing loss it will not continue to get worse if you diligently protect your years from loud noise.
Hazard control and shop equipment	55/68	An emergency eyewash station cannot consist of two hand-held bottles of saline eye wash solution.
	Explanation: OSHA requires that emergency eyewash stations that provide a 15-minute continuous flow are available within 50 ft. <sup>37</sup>	
Personal protective equipment	70/76	Safety glasses do not protect your eyes from chemical splashes.
	Explanation: Safety glasses are suitable for protection from particulates, but only goggles are effective in protecting the eyes from chemical vapors, droplets, or splashes. <sup>38</sup>	
Training and respirator clearance	55/60	Medical evaluation for respirator users must be administered during regular working hours.
	Explanation: Employees must be medically certified to use a respirator prior to it being fit-tested. Evaluation must take place during normal working hours. <sup>39</sup>	

**TABLE 5.** Percent Responses to Open-Ended Questions by Type of Answer

Answer Category	Correct	In the Ballpark*	Incorrect	Unrelated <sup>†</sup>	I Don't Know/Missing
	% Post-Secondary/% Secondary				
1. An acid or a base that can burn or damage the skin and eyes is referred to as.... "corrosive"	30/36	21/4	25/24 "solvent"	13/20 "rash"	11/16
2. What is the most important characteristic of an electrical current that determines the health effects in case of electrocution? amperage	41/16	0	20/24 "voltage"	22/32 "nervous system damage"	17/28
3. For collision shop workers, the most important health problem caused by isocyanates is.... asthma	18/20	33/24 "breathing problems"	44/28 "nerve damage"	2/16 "sanding and painting"	3/12
4. List one performance characteristic of an OSHA-compliant compressed air gun. less than 30 psi when placed against the skin	17/28	26/8 "limiting air pressure"	19/28 "has rubber tip"	22/16 "blowing off parts to be painted"	16/20
5. A respirator with pink/magenta filters (label code P 100) removes _____ from the air. dust, fumes	82/80	4/0 "nuisance particles"	7/8 "acid"	2/0 "HEPA particle filter"	5/12

\*In the ballpark indicates that an answer might be construed as correct but was inaccurate.

<sup>†</sup>Unrelated answers were responses that had no relationship to the correct response.

However, many recognized the importance of “limiting air pressure.” About one-fifth (22%) of the postsecondary instructors and 16% of secondary instructors provided answers unrelated to the question regarding Occupational Safety and Health Administration (OSHA)-required performance characteristics of compressed air guns. Many of the unrelated answers were related to spray painting gun characteristics. Although spray painting guns also work by being connected to a compressed air hose, their performance is regulated by the Environmental Protection Agency (EPA).

Nearly all instructors (80%) knew that respirator filters designated by the code P100 removed dusts and fumes from the air. There were few unrelated or incorrect answers to this question.

## DISCUSSION

Employees in the collision repair industry encounter a variety of chemical, electrical, fire, and mechanical hazards. Hazardous chemicals include isocyanates, solvents, and acids. Among the 49 collision shops participating in the Collision Auto Repair Safety Study (CARSS), only 8% of businesses had a complete respiratory protection program, 10% had conducted chemical Right-to-Know training, and 15% had medically evaluated and fit-tested respirator users.<sup>28,40</sup>

The survey results described in this paper indicate that the respondents have significant gaps in OSH-related knowledge. These findings are consistent with other studies of CTE faculty. For example, a survey of 156 Australian high school teachers found that only one of six teachers had received formal OSH training.<sup>33</sup> A survey of Finnish teachers found that 40% received OSH training as part of their basic teacher education, 32% had attended separate occupational safety courses, and 28% had no formal OSH education.<sup>41</sup>

In the TECHS survey, instructors’ knowledge of OSH did not increase with years of experience working in collision repair and/or teaching. Interviews and focus groups with collision repair business owners and workers have documented knowledge gaps and only a partial understanding of the health effects of the hazardous chemicals commonly used in this industry.<sup>31</sup>

For example, exposure to isocyanates occurs primarily through inhalation; however, skin contact is also a significant route of exposure.<sup>42</sup> Isocyanates are commonly found in paints and clear coats sprayed on a vehicle to restore its appearance after it is repaired. Fewer than half of instructors knew that skin contact with isocyanates may occur during operations such as removing masking tape. This is problematic not only because it’s a common operation in collision shops, but because technicians may not recognize the need to wear gloves to prevent dermal exposure. Isocyanates are a leading cause of work-related asthma in general and in ABCT in specific.<sup>6,37,43</sup>

In addition, a large percentage of instructors believed that cancer or brain damage were the most important adverse effects of isocyanate exposure. Perpetuating such inaccuracies is problematic because technicians who do not know that isocyanates are an important cause of asthma may fail to adequately protect themselves, miss opportunities to connect early symptoms to their occupational exposure, or fail to find substitute products.

As a second example, many operations conducted in collision shops expose technicians to eye hazards. These include flying particles from grinding, arc flash from welding, and washing with and spraying chemicals.<sup>40</sup> Safety glasses are suitable for protection from particulates, but only goggles are effective in protecting the eyes from chemical vapors, droplets, or splashes. In the current study, about 25% of the instructors did not appear to understand the difference between the two types of eye protection.

Further, when handling corrosive liquids in a manner that may result in splashing, an emergency eyewash station that provides a 15-minute continuous flow must be available within 50 ft.<sup>34</sup> This requirement was intended to ensure that a technician can assist with first aid by holding their eyes or those of a coworker open when

rinsing the chemical contamination. However, almost half of the instructors participating in the study perceived hand-held bottles of saline solution to fulfil the OSHA standard requirement. Holding one’s eyes open and delivering a saline solution rinse at the same time is not plausible; and, failing to provide adequate first aid could result in permanent damage to the eyes.

While the majority of instructors felt the responsibility for health and safety is shared by owners and workers, a surprising number thought it is entirely the responsibility of workers. In addition, most faculty (85%) felt they did not have enough time to teach OSH. This belief indicates that there may be structural problems within vocational training. These findings are consistent with key informant interviews held with instructors in which they reported a rapid transition into teaching and no defined curriculum for teaching OSH. For example, one instructor stated he frequently used personal stories as a means of teaching: “Past experience from me not wearing respiratory protection while priming on the job that led to my need for sinus surgery. That they need to learn from my mistakes. . . .”<sup>7</sup> While useful, stories were usually ad hoc and thus provided only to those who were present at a specific time.

In summary, the results of this survey demonstrate substantial gaps in the OSH-related knowledge among ABCT instructors at the secondary and postsecondary levels. Vocational instructors play a central role in preparing the new generation of collision repair technicians; however, they cannot teach what they don’t know. They are also likely to be less effective when teaching concepts they don’t understand. A recent survey conducted in vocational colleges in Minnesota found that graduates have significant knowledge gaps regarding safety and health in their trade.<sup>18</sup> Without addressing instructors’ safety and health knowledge gaps, successful implementation of safety and health curricula developed specifically for collision repair programs is likely to be incomplete and ineffective. As a result, new generations of technicians will continue to enter the workforce poorly prepared to protect their health and safety, missing the chance to have fulfilling and successful careers.

The Quebec City Protocol for the Integration of Occupational Health and Safety Competencies into Vocational and Technical Education,<sup>35</sup> an international collaboration of OSH institutions in nine countries, recommends that educational organizations work in partnership with OSH professionals and the business community to define and integrate OSH competencies into vocational programs and to ensure that teachers and instructors receive training specific to their trade prior to teaching.

## Limitations

The instructors invited to participate in this study taught in institutions that had previously collaborated with CREF. Information is not available with regard to how these institutions compare with other schools that teach collision repair to secondary and postsecondary students. In addition, we were unable to stratify results by state because hiring criteria varies between states and the small number of responses received from any one state. Lastly, this survey did not collect data regarding professional development courses or previous safety and health training instructors may have received.

## CONCLUSIONS

Results from the current study demonstrate substantial gaps in OSH-related knowledge among secondary and postsecondary ABCT instructors.

Without addressing gaps in instructor knowledge, the successful implementation of OSH curricula developed for collision repair in specific and other trades in general is unlikely to be effective and workers will continue to enter the workforce unprepared to protect their wellbeing and that of their coworkers. It is unlikely that many new workers will receive substantive training after entering the workforce. Therefore, to protect the health and

well-being of the future workforce, it is critical that schools, OSH professionals, and employers collaborate to ensure that teachers and instructors receive training specific to the hazards, risks, and control methods of their trade.

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