Journal of Safety Research 71 (2019) 191–200

Contents lists available at ScienceDirect

Journal of Safety Research

journal homepage: www.elsevier.com/locate/jsr

Motor vehicle towing: An analysis of injuries in a high-risk yet understudied industry

Mark D. Chandler *, Terry L. Bunn

Kentucky Injury Prevention and Research Center, Bona Fide Agent for Kentucky Department for Public Health, University of Kentucky, College of Public Health, Lexington, KY

ARTICLE INFO

Article history:
Received 26 April 2019
Received in revised form 24 August 2019
Accepted 6 October 2019
Available online 16 November 2019

Keywords:
Motor vehicle towing
Tow truck operator
Fatality
Catastrophe
OSHA

ABSTRACT

Objectives: National fatality rates for commercial tow truck operators exceed those of other first responders who also perform traffic incident management services. The objectives of the current study are to (1) characterize causal factors associated with injuries among commercial tow truck operators engaged in roadside assistance through analysis of coded and free text data obtained from U.S. Occupational Safety and Health Administration (OSHA) investigation files, and (2) utilize supplemental data sources to analyze environmental factors for injuries in which commercial tow truck operators were struck by roadway traffic. *Methods*: Searches of OSHA's online IMIS database were performed to identify investigations of incidents in which tow truck operators were injured while performing roadside assistance duties. Freedom of Information Act (FOIA) requests were submitted to obtain full investigation files for each case. Coded and narrative text analyses were performed to identify causal themes across the identified cases. *Results*: One-hundred and six cases of tow truck operators being killed or severely injured were identified in IMIS; 41 FOIA requests for related investigation documents were fulfilled. Two major event type themes were identified which accounted for 9 in 10 of the cases identified. These were (1) 'struck-by' incidents, which were primarily injuries resulting from contact with roadway traffic, rolling vehicles and equipment or other non-motorized objects; and (2) 'caught-in or -between' incidents, which were primarily injuries resulting from being pinned beneath and between vehicles and being caught in moving parts. *Conclusions*: The towing industry should provide initial and refresher safety training on vehicle loading and unloading, defensive techniques when exposed to traffic on roadways, and proper wheel chocking and braking procedures. States should include tow trucks as a first responder vehicle type in their "Move Over" laws and implement public awareness campaigns to protect all first responders, including tow truck operators.

1. Introduction

According to the U.S. Bureau of Labor Statistics (BLS), there were 231 work-related deaths in the motor vehicle towing industry (MVT) from 2011 to 2017 (Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019, 2011, 2017). Thirty-seven percent of those deaths involved the tow truck operator being struck by roadway traffic (hereafter referred to as pedestrian struck-by incidents), 16% were struck-by incidents involving objects or equipment, and 14% were acts of violence. There were 32 injuries for every death over that same time period (Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019, 2011, 2017; Nonfatal Cases Involving Days, 2011). Even when injuries in MVT are not fatal, BLS data suggests that they are still serious and disruptive: one-fourth all nonfatal injuries reported between 2011–2017 ($N = 7{,}380$) resulted in at least 31 days away from work; most nonfatal injuries resulted from contact with objects of equipment (32%); overexertion and bodily reaction (30%); transportation incidents (14%); and falls, slips, and trips (14%) (Nonfatal Cases Involving Days, 2011).

1.1. Injury risk compared to other first responders

Tow truck operators provide a variety of roadside assistance services to motorists, including on-demand passenger car towing, commercial vehicle towing, and roadside vehicle repairs. They also

* Corresponding author.
E-mail address: mchandler@safekids.org (M.D. Chandler).

https://doi.org/10.1016/j.jsr.2019.10.006
0022-4375/

perform essential traffic incident management (TIM) functions in coordination with fire, police, and emergency medical services in the aftermath of motor vehicle crashes by removing disabled vehicles, clearing incident debris, and cleaning up spilled cargo (Owens, Armstrong, & Sullivan, 2010). Although they work closely with other first responders, statistics show that they are at significantly greater risk for occupational mortality due to pedestrian struck-by incidents (Bunn, Slavova, Chandler, Hanner, & Singleton, 2018; Census of Fatal Occupational Injuries, 2011; Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019, 2011, 2017). BLS data shows there were 67 police protection industry workers killed between 2011 and 2017 in pedestrian struck-by incidents (Census of Fatal Occupational Injuries, 2011); comparatively, 64 workers employed in MVT were killed in the same manner (Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019, 2011, 2017). Previous research findings by the authors found the fatality rate for MVT to be as much as double the rates for police protection and fire protection industries from years 2005–2015 in the U.S. (Bunn et al., 2018).

1.2. Previous studies

These statistics underscore the need for further research to guide the development of effective safety controls; yet, the literature largely overlooks this high-risk population. The authors' previous research findings calculated the 2015 U.S. fatality rate for the motor vehicle towing industry to be 54.6 per 100,000 workers (Bunn et al., 2018). Comparatively, the fatality rate for general industry was 3.4 per 100,000 workers for that same year (Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019, 2011, 2017). We postulated the elevated rate may be due to several factors, including that (1) tow truck operators spend a greater amount of time openly exposed to roadside hazards while loading vehicles, whereas police and fire protection workers may be better equipped to use their vehicles as a physical barrier to traffic during TIM response; (2) tow trucks aren't classified as emergency response vehicles, so they use yellow emergency lights that may not be as distinguishable to motorists as those used by fire, police, and emergency medical services vehicles; and (3) the flashing light bars on the top of tow trucks may become obscured to motorists while vehicles are being loaded onto the tilted flatbed. Injury scenario text analysis showed that tow truck drivers in Kentucky were most at risk while loading a vehicle at roadside. Notably, to the authors' knowledge, this was the first study to identify and characterize hazards in MVT.

Analyses of MVT hazards outside of peer-reviewed literature are scarce. Funded by the National Institute for Occupational Safety and Health (NIOSH), Fatality Assessment and Control Evaluation (FACE) programs conduct surveillance of occupational fatalities in their respective states and perform targeted on-site investigations of fatalities that fall within their state's priority areas (NIOSH. Fatality Assessment and Control Evaluation (FACE) Program. Accessed. https://www.cdc.gov/niosh/face/. Published 2019, 2019; Higgins, Casini, Bost, Johnson, & Rautiainen, 2001). Although limited in number, FACE reports have been released which detail the findings of systematic investigations into MVT fatalities. Using a variety of source documents, including Occupational Safety and Health Administration (OSHA) investigation reports, FACE reports detail potential contributing factors to the fatality and offer safety recommendations to prevent future injury. MVT incidents detailed in these case reports include tow truck operators being struck and killed by traffic while entering their cab and while securing disabled vehicles for transport (Owner of Towing Company, 2014; Tow Truck Driver, 2016, 2017; Unloading, 1999; Struck, 2015), as well as workers being fatally crushed beneath or pinned by customer vehicles (Car, 2008; Unloading, 1999; Truck, 2001). Potential contributing factors highlighted in these reports include inadequate safety training, lack of portable warning device and high visibility personal protective equipment (PPE) use, and the presence of intoxicated motorists (Owner of Towing Company, 2014; Struck, 2014; Tow Truck Driver, 2008, 2017; Struck, 2015).

1.3. OSHA investigation activities

To improve the safety of workers, industries typically use past incidents as a teaching tool Chua and Goh (2004). OSHA investigates workplace fatalities and serious injuries to identify root causes in order to prevent similar incidents from recurring. Currently, there are 28 states that fall under Federal OSHA jurisdiction and 21 states and one territory that have their own State Plan offices presiding over both private sector and state and local government workers, and there are six states which cover only state and local government workers (Occupational Safety and Health Administration, U.S. Department of Labor. State Plans. Accessed. https://www.osha.gov/dcsp/osp/. Accessed March 3, 2019, 2019). State Plans are monitored by OSHA and are required to be at least as effective as OSHA in protecting workers.

Under 29 CFR 1904.39(a)(1), most employers in all states are mandated to report to OSHA a worker fatality within eight hours and any amputation, loss of an eye, or hospitalization of a worker within 24 hours Chua and Goh (2004). OSHA investigates all fatalities and catastrophes in covered workplaces. Prior to 2015, a 'catastrophe' was defined as an incident that resulted in the hospitalization of three or more workers (Occupational Safety and Health Administration, U.S. Department of Labor. Updates to OSHA's Recordkeeping Rule: Reporting Fatalities and Severe Injuries. Accessed. https://www.osha.gov/recordkeeping2014/OSHA3745.pdf. Accessed March 18, 2019, 2019). Since 2015, only one worker hospitalization is required for the incident to be investigated as a catastrophe. Fatality and Catastrophe Investigation Summaries (OSHA 170 forms) are completed after Federal or State Plan OSHA conducts an investigation of a work-related fatality or catastrophe. Abstracts for these investigations are made publicly available online through OSHA's Integrated Management Information System (IMIS) database and describe the events surrounding an incident, including situational and causal factors. A detailed free-text narrative description of how each event occurred is also included. These narrative portions provide information for which the coded data in the abstract doesn't capture, such as causal factors, event time, and victim activity and location at the time of the incident.

However, OSHA reporting requirements for investigations of roadways incidents are less stringent. Under 29 CFR 1904.39(b)(3), employers are exempt from requirements to immediately report fatalities and serious injuries if the incident occurs on a public road (e.g., streets, highways), unless in a construction zone (Occupational Safety and Health Administration, U.S. Department of Labor. Standards for recording and reporting occupational injuries and illness under 29 1904, 1904). Further, OSHA is not required to investigate roadway incidents and instead often defers to state and local law enforcement as the investigating authority.

Still, as the primary agency responsible for worker safety, OSHA does at times investigate roadway MVT incidents on a discretionary basis, and abstracts for these investigations are stored in the IMIS database. While they do not capture all MVT incidents, these abstracts provide detailed coded and narrative text data regarding MVT injuries that is otherwise widely unavailable to the public.

1.4. Narrative text analyses

Unstructured and semi-structured narrative and free-text data sources, such as those found in IMIS and full OSHA investigation reports, provide a valuable and often untapped resource for analyses and development of safety interventions based on analyses findings. Like FACE programs, multiple researchers have employed narrative text analysis to supplement coded data sources (Brown, 2016; Chandler, Bunn, & Slavova, 2017; Goh & Ubeynarayana, 2017; McKenzie, Scott, Campbell, & McClure, 2010; Vallmuur et al., 2016; Yamin, Bejan, Parker, Xi, & Brosseau, 2016). The documented benefits of this approach include (1) the identification of cases that are undetectable by coded elements alone, (2) extracting more detailed information that rigid coded data fields don't allow and translating it into useable, detailed injury event information, and (3) characterizing chains of events and cause detail not found in singular code fields (McKenzie et al., 2010; Vallmuur et al., 2016). Data text mining has become increasingly more prevalent due to the large amounts of unstructured data available in documents, news reports, research papers, and accident reports (Brown, 2016).

1.5. Freedom of Information Act

Enacted in 1966, the Freedom of Information Act (FOIA) (5 USC. § 552) allows the public the right to request access to documents held by federal agencies U.S. Department of Justice. The Freedom of Information Act. 1966 (1966). OSHA is lawfully required to disclose such records that have been properly requested in writing by any person, unless the release of such records would threaten personal privacy, national security, or law enforcement. FOIA has been shown to be a powerful tool for obtaining information on issues that are important to public health research and practice (Rosenbaum & Berger, 2011).

Previous studies have demonstrated the utility of using IMIS to identify and study occupational injury and illness investigations data, with topics including worker falls, nail gun injuries, asphyxiation, and poisonings (Henn, Bell, Sussell, & Konda, 2013; Lowe, Albers, Hudock, & Krieg, 2016; Rosenman et al., 2006; Sayler, Roberts, Manning, Sun, & Neitzel, 2019; Siddiqui S. U.S. construction worker fall accidents: Their causes and influential factors. [Master's Thesis]. Miami, FL: Florida International University; 2014, 2014). Further, FOIA requests have served as a vehicle for extracting such data and for obtaining additional information not typically included in publicly accessible government datasets (Blodgett, Suruda, & Crouch, 2001; Sayler et al., 2019; Siddiqui S. U.S. construction worker fall accidents: Their causes and influential factors. [Master's Thesis]. Miami, FL: Florida International University; 2014, 2014). At the time of writing, the authors are unaware of any studies which have analyzed data obtained from abstracts stored in IMIS for MVT.

1.6. Study objectives

The objectives of this study are to (1) characterize causal factors associated with injuries among commercial motor vehicle towing operators engaged in roadside assistance through analysis of coded and free text data obtained from U.S. Occupational Safety and Health Administration (OSHA) investigation files, and (2) utilize supplemental data sources to analyze environmental factors for injuries in which commercial tow truck operators were struck by roadway traffic.

2. Methods

2.1. IRB approval

This study was approved by the University of Kentucky Institutional Review Board; no consent was required as all data to be used were de-identified and publicly accessible.

2.2. Data sources

2.2.1. IMIS data

Data from fatality and catastrophe investigation abstracts were obtained from the OSHA IMIS database for years 2002–2017 (Table 1). Industry is coded in IMIS using the North American Industrial Classification System (NAICS) and/or Standard Industrial Classification (SIC) code. Although NAICS codes have undergone iterative changes since 2002, the coding for MVT has remained unchanged and thus no crosswalk is required for data analysis. Occupation is coded in IMIS using the 2000 and 2010 Standard Occupational Classification (SOC) System. Search parameters available to users in IMIS at the time of writing included free-text event description, abstract, and keyword fields; NAICS code; investigation number; event date; and investigation open and closing dates. Searches were performed using the 2012 NAICS code for MVT (488410). Keyword searchers were then performed to capture tow truck operators working in establishments that are classified outside of the MVT NAICS code. Search terms included 'tow truck,' 'towing,' 'motor vehicle towing,' 'wrecker,' 'flatbed,' 'integrated,' 'wheel-lift,' 'hook and chain,' and 'wrecker.'

2.2.2. Supplemental weather and roadway characteristics

Data on weather conditions for each case were retrieved from WeatherUnderground.com. Similarly used in FACE program investigation reports, WeatherUnderground provides historic hour-by-hour weather condition records based on date and zip code, with

Table 1
Data fields extracted from IMIS abstracts for analysis.

Injury/Event details	Demographics	Establishment details	Investigation details	Violation details
Detailed description	Age	NAICS	Investigation number	ID
Event date	Sex	Union status	Investigation office	Type
Incident address	Occupation	Ownership	Investigation type	Standard
Degree			Open date	Issuance
Nature			Close conference	Abate date
Event state			Close date	Current penalty (Curr$)
			Advanced notice	Contest date
			Scope	

details including humidity, precipitation, and light conditions. While OSHA investigation documents do not typically collect coded fields for roadway characteristics, IMIS abstracts do include the incident address and proximity to mile marker posts. These location approximations were entered into Google Maps Street View to identify roadway characteristics (i.e., number of lanes, type of roadway, speed limit, and roadway alignment) for each incident scene.

2.3. Case inclusion

Cases in IMIS were included in the study if they described a tow truck operator who was injured while performing roadside vehicle assistance, including unloading of vehicles at towing destinations. Cases were excluded if any of the following were true: (1) the object being serviced or towed was not a motor vehicle (e.g., a mobile home, trailer, or non-motorized equipment), (2) a vehicle other than a commercial tow truck was being used as a tow vehicle (e.g., a tractor, non-commercial passenger vehicle, or boat), or (3) the injured victim was not actively performing towing or roadside assistance duties when injured (e.g., on break, performing unrelated duties at the shop, or driving from one location to another while not responding to a call for assistance). A total of 141 fatality/catastrophe abstracts were initially identified in IMIS for years 2002–2017 for incidents involving tow truck operators. Thirty-five of these cases were removed for not meeting our inclusion criteria, resulting in a total of 106 cases included in the study.

2.4. FOIA requests

Formal written FOIA requests were mailed to the appropriate Federal and State Plan OSHA offices to obtain the following investigations documents for each of the 106 final study cases: (1) OSHA Citations & Notification of Penalty, (2) OSHA Investigation Report, (3) OSHA Safety Narrative, (4) OSHA Investigation Summary, (5) OSHA Fatality/Catastrophe Report, and (6) OSHA Worksheet. FOIA requests for 41 (39%) of the identified cases were fulfilled—documents for 20 cases were received by email, 10 by parcel mail in disc form, and 11 by parcel mail in print form. More than half (61%) of the FOIA requests were not fulfilled, primarily due to requests remaining in queue for processing ($N = 21$, 20% of all requests), case investigation files being destroyed per retention schedules ($N = 16$, 15% of all requests), and general lack of acknowledgement of submitted requests despite multiple follow-up attempts by the requestor ($N = 27$, 25% of all requests).

2.5. Narrative text coding

An analysis of the free-text narratives contained in IMIS abstracts and supplemental investigation documents was conducted to better understand the worker's activity at the time of injury as well as the event type. Injury codes constructed from the narrative text analysis were 'event time,' 'event day of the week,' 'event month,' 'event season,' 'event type,' 'source or exposure,' 'activity,' 'reflective vest use,' 'emergency warning device use,' and 'light bar use'. Event type was coded based on International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM). 'Source or exposure' was coded as the immediate external source or exposure that led to injury, and 'activity' was determined as the general activity the tow truck operator was engaged in at the time of injury. For instance, if the abstract narrative read "tow truck driver was securing the straps to a vehicle he had just loaded when he was side swiped by a passing vehicle," the 'event type' would be coded as 'struck by,' 'source or exposure' would be coded as 'vehicle driven by motorist,' and 'activity' would be coded as 'loading/securing vehicle to tow truck'.

Major injury domains and categories were constructed based on the most frequent 'event type,' 'source or exposure' and 'activity' codes. Taken together, these codes provide a cohesive picture of what type of injury occurred and during what activity. If there were fewer than three cases for specific injury activity codes that fell within a domain category, then those cases were grouped together in the 'other' category.

3. Results

3.1. Demographics

'Age,' 'sex,' 'industry of employment,' and 'occupation' were the only demographic characteristics coded in IMIS for the identified cases. 'Age' and 'sex' fields were only populated for 23 (22%) of the 106 cases. Review of the IMIS abstract narratives and supplemental investigation documents further identified sex for all but 6 (92%) of the cases—all but one were male. The same narrative review was only successful in further determining victim age in 49 (46%) of the 106 total cases—using this incomplete data, average age was 43 years old for fatal and 45 years old for nonfatal injuries.

3.2. Establishment details

Table 2 displays cases grouped by their four-digit NAICS industry group code and occupation, as coded in IMIS. Most cases were coded under the 'Support activities for road transportation' industry group (86%), all but one of which were motor vehicle towing' (NAICS code 488410). Occupation for 32% of cases were coded as 'occupation not reported'. 'Truck drivers, light' and 'Truck drivers, heavy' were the most common occupation codes (25% and 18%, respectively), followed by 'motor transportation occupations n.e.c.' (8%). All establishments were coded in IMIS as 'nonunion' for 'union status'. For establishment 'ownership,' 105 were coded as 'private' and only one as 'local government.'

Table 2
Cases by industry group and occupation as coded in IMIS.

Industry (4-digit 2012 NAICS)	N	Percent*
4884 – Support activities for road transportation	91	86%
8111 – Automotive repair and maintenance	7	7%
4231 – Motor vehicle and motor vehicle parts and supplies merchant wholesalers	1	1%
4251 – Wholesale electronic markets and agents and brokers	1	1%
4543 – Direct selling establishments	1	1%
4889 – Other support activities for transportation	1	1%
5614 – Business support services	1	1%
5622 – Waste treatment and disposal	1	1%
8113 – Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	1	1%
Not reported	1	1%
Occupation	N	%
Occupation not reported	34	32%
Truck drivers, light	26	25%
Truck drivers, heavy	21	20%
Motor transportation occupations n.e.c.	8	8%
Tow truck operator	4	4%
Garage and service station related occupations	3	3%
Not provided	3	3%
Automobile mechanics	2	2%
Automobile mechanic apprentices	1	1%
Crane and tower operators	1	1%
Equipment Operator: Heavy	1	1%
Heavy equipment mechanics	1	1%
Hoist and winch operators	1	1%

* Percent totals do not equal 100 due to rounding.

3.3. Regional distribution of investigated cases

Overall, roughly one-third (32%) of cases were for incidents occurring in OSHA Region 9, which covers AZ, CA, NV, HI, American Samoa, Guam, and the Trust Territories of the Pacific (Table 3). Nearly 90% of cases were for investigations occurring in OSHA Region 9, most of which (87%) were conducted in California (state-level frequency data not shown). There were 21 states for which no fatality/catastrophe investigation abstracts were identified. Four states accounted for all nonfatal investigation cases.

3.4. Injury details

3.4.1. Degree and nature

Most investigations were initiated in response to a fatal injury (68%). Nature of injury codes most frequently documented for fatalities were 'other' (52%), 'fracture' (15%), and 'asphyxia' (14%) (data not shown). 'Fracture' was the leading nature of injury for nonfatal injuries (53%), most of which resulted from being struck by motorists and equipment while working outside of the tow truck. 'Amputation' was the second most commonly coded nature of injury for nonfatal injuries (15%); these were the result of pedestrian struck-by incidents and limbs and appendages being caught in machinery and moving towing apparatus parts.

3.4.2. Event type

Cases were assigned the following 'event type' categories based on narrative text analysis: 'struck by' ($N = 70$, 66%), 'caught-in or -between' ($N = 28$, 26%), 'falls' ($N = 4$, 4%), and 'all other' ($N = 4$, 4%) (data not shown). 'Struck by' and 'caught-in or -between' injuries were the leading cause of both fatal and nonfatal injuries (71% and 24%, 55% and 30%, respectively). The 'all other' category included incidents of drowning, burns, and struck against.

3.5. Injury domains

'Struck by' and 'caught-in or -between' were the major event type domains constructed from the narrative text analysis, together accounting for 92% of the identified cases. From these domains, six source of injury categories emerged through analyses of investigation narratives (Table 4).

3.6. Domain 1: 'struck by' incidents

Categories that emerged in this domain included being struck by vehicles driven by motorists, rolling tow truck or vehicles being towed, and other equipment or non-motorized objects.

Table 3
Case totals for OSHA region by degree of injury.

	Fatal injury*	Non-fatal injury*
Region 1 (CT, MA, ME, NH, RI, VT)	5 (7%)	–
Region 2 (2 – NJ, NY, Puerto Rico, Virgin Islands)	6 (8%)	–
Region 3 (D.C., DE, MD, PA, VA, WVA)	10 (13%)	1 (3%)
Region 4 (AL, FL, GA, KY, MS, NC, SC, TN)	21 (28%)	–
Region 5 (IL, IN, MI, MN, OH, WI)	12 (16%)	–
Region 6 (AR, LA, NM, OK, TX)	4 (5%)	–
Region 7 (IA, KS, MO, NE)	2 (3%)	–
Region 8 (CO, MT, ND, SD, UT, WY)	3 (4%)	–
Region 9 (AZ, CA, NV, HI, American Samoa, Guam, Trust Territories of the Pacific)	8 (11%)	26 (87%)
Region 10 (AK, ID, OR, WA)	5 (7%)	3 (10%)
Total	76	30

* Percent totals do not equal 100 due to rounding.

3.6.1. Struck by vehicle driven by motorist

Thirty-seven percent of all cases involved the victim being struck by vehicular traffic while working on foot ($N = 39$), most of which were fatal ($N = 33$). Tow truck operators were most at risk while in the act of loading or securing vehicles for towing. Major causal factors included vehicles crossing the fog line as well as the tow truck operator inadvertently stepping into the path of approaching traffic while securing loads from the traffic-facing side of the tow truck. Two victims were killed when they were exiting their tow truck cab on the traffic-facing side and a vehicle struck them, and another after he had finished securing a vehicle and was entering the cab with his back turned to traffic.

3.6.2. Struck by rolling tow truck or vehicle being serviced

Twenty-nine percent of cases involved the tow truck or vehicle being serviced unexpectedly rolling and striking the victim. Five fatalities occurred when the victim was working beneath the vehicle to disengage the drive shaft and the vehicle either fell from its temporary support structure (e.g., blocks, hoist) or began to roll due to not first setting the brake and/or chocking the wheels. Parking brake failure and not setting the parking brake led to three workers being fatally struck by the rolling tow truck as they exited the cab.

3.6.3. Struck by equipment or other non-motorized object

Two victims were killed and two more were injured when the drive shaft unexpectedly fell and struck them in the face or head as they were working to disengage it from beneath a vehicle. Other incidents included facial injuries due to towing chain breakage, logs falling from overturned log trucks, and being struck by a jacking apparatus.

3.7. Domain 2: 'caught-in or -between' incidents

Categories that emerged in this domain included being caught under vehicles, between rolling vehicle and another vehicle, and between moving mechanical parts.

3.7.1. Caught under vehicle

Being caught under vehicles accounted for 14 (13%) of all cases identified in the study and was the leading source category for 'caught- in or -between' incidents, most of which ($N = 12$) were fatal. Four victims were killed as they were in the process of releasing towing straps, chains, and hooks to unload a towed vehicle at its destination when the vehicle fell on them. Three additional victims were killed when they disengaged a drive shaft, shift linkage or transfer case from beneath a raised vehicle and the vehicle shifted and fell, resulting in fatal crushing injuries. Failure to properly stabilize the towed vehicle prior to unloading procedures was noted as a causal factor throughout the investigations, including failure to use wheel chocks and or engage the parking brake. Other causal factors included resting the front tires of loads on wooden blocks rather than properly rated wheels stands, as well as operating towing controls from beneath a raised load.

3.7.2. Caught between rolling vehicle and another vehicle

Being pinned between two vehicles, one of which was rolling, resulted in four fatal and four nonfatal injuries. Three tow truck operators were killed and one was injured in this manner while unloading vehicles. Incidents included victims attempting to stop a rolling vehicle by placing themselves in its path, as well as customers accidentally exiting their vehicle without first placing it in park. Causal factors frequently noted throughout the investigation documents were failure to properly chock the wheels of vehicles to prevent them from rolling and failure to use properly rated wheel stands to elevate the wheels of a disabled vehicle. One case

Table 4
Event type domain, source or exposure of injury category, and related activity.

Event Type Domain*	Source or Exposure Category	Activity Category
Struck by N=70 (66% of all cases)	Vehicle driven by motorist (N=39)	Loading/securing vehicle to tow truck (N=21)
		Assisting/retrieving disabled vehicle, non-specific (N=6)
		Entering/exiting tow truck cab (driver's side) (N=3)
		All other(N=9) *
	Rolling tow truck or vehicle being towed (N=21)	Disengaging drive shaft (N=5)
		Entering/exiting tow truck cab (N=3)
		All other (N=13)
	Equipment or other non-motorized objects (N=10)	Disengaging drive shaft (N=4)
		All other (N=6) *
Caught-in or -between N=28 (26% of all cases)	Under vehicle (N=14)	Unloading vehicle (N=4)
		Disengaging drive shaft/shift linkage/transfer case (N=3)
		Loading/securing vehicle to tow truck (N=3)
		All other (N=4)*
	Rolling vehicle and another vehicle (N=8)	Unloading vehicle (N=4)
		All other (N=4) *
	Moving parts (N=6)	All other (N=6) *

* Activities with counts of fewer than 3 were grouped together in the 'all other' category.

involved a tow truck operator operating the towing apparatus controls while in the travel path of the vehicle being unloaded.

3.7.3. Caught in or between moving parts

Two fatal and four nonfatal injuries occurred when victims' bodies, limbs, or appendages were caught in moving mechanic parts. Nature types for these incidents included amputation, asphyxia, cut/laceration, and fracture. Incidents included tow truck operators getting fingers caught or amputated in dolly assist arms and beneath T bars, as well as a foot being amputated after it was smashed between a rollback bed and the asphalt. One fatal pinning incident occurred when the victim entered between the raised flatbed and the frame of the truck without realizing his coworker was returning the flatbed to its stowed position.

3.8. High-visibility safety apparel and light bar use

Narrative information regarding high-visibility safety apparel (HVSA) use was only available for 20 of the 39 cases in which the victim was struck by roadway traffic (data not shown). Of these, 11 narratives indicated the victim was wearing HVSA at the time of the incident while 9 indicated they were not. Similarly, emergency light bar use was only identifiable in 19 of the 39 traffic struck-by cases. All 19 of these cases described the emergency light bar as being active at the time of the incident. HVSA and light bar use was typically not indicated in the IMIS abstracts and instead was retrieved from the FOIA-requested investigation documents.

3.9. Environmental analysis of pedestrian struck-by incidents

3.9.1. Roadway characteristics

Most of the 39 victims struck by roadway traffic were struck on a two-way divided roadway (79%), while the remainder were struck on a two-way undivided roadway (21%) (data not shown). More than half ($N = 23$, 59%) of the roadways were comprised of two lanes for traffic flow, 12 (31%) had three to five lanes, and 1 (3%) had only one lane. Number of lanes could not be determined for 3 (8%) of pedestrian cases due to insufficient location detail. The speed limit was 65 mph or greater for 19 (49%) of cases, 45 mph to 60 mph for 15 (39%) of the cases and 35 mph and under for 2 (5%) of the cases. Location data was insufficient to determine speed limit for 3 (8%) of the cases. The roadway alignment was predominantly straight ($N = 23$, 59%) with 9 (23%) having a curvature to the left or right. Roadway alignment could not be determined for 7 (18%) of the cases due to insufficient location detail.

Only 8 (21%) of pedestrian struck-by incidents occurred on two way, undivided roadways, 75% of which occurred in speed limit zones of 45 to 60 mph. Roadway alignment being straight (as opposed to curved) was the leading roadway alignment for all speed limit ranges; 65 to 70 miles per hour was the speed limit range with the highest percentage of pedestrian struck-by incidents occurring in curves.

Fall was the season with the most pedestrian struck-by incidents while spring had the fewest ($N = 14$ and $N = 7$, respectively) (data not shown). Light conditions were dark for 43% of pedestrian struck-by incidents, dusk/dawn for 8%, daylight for 26%, and unknown for 23%. While the Weather Underground historical data indicated fair-weather conditions for 44% of the pedestrian struck-by incidents, 40% of them occurred in partly cloudy to mostly cloudy conditions. Finally, nearly one in four (23%) of the pedestrian struck-by incidents transpired while it was both cloudy and partly to fully dark outside.

4. Discussion

To the authors' knowledge, this study is the first to identify and describe the environmental, behavioral, and situational factors associated with injury among workers in MVT. Analysis of both coded and narrative text data contained in OSHA investigation documents provided a unique opportunity to further examine the hazards routinely encountered by tow truck operators providing roadside vehicle assistance. Our review of the IMIS database

captured Federal and State OSHA Plan investigation abstracts for 73 fatal and 33 nonfatal injuries in MVT for years 2002 through 2017. Most victims were male, which is consistent with BLS fatal and nonfatal injury counts and likely due to trucking transportation being a male-dominated industry (Bureau of Labor Statistics, U.S. Department of Labor. Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity. Accessed. https://www.bls.gov/cps/cpsaat18.htm. Accessed March 15, 2019, 2019; Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019, 2011, 2017).

The most noteworthy findings in this study relate to the identification of 'struck-by' and 'caught-in or -between' events as the two major event type domains, together accounting for 92% of the investigations included in the study. Most investigations were carried out in response to struck-by incidents, predominantly pedestrian struck-by incidents (37% of all cases). CFOI similarly reports that, over a seven-year period (20011–2017), pedestrian struck-by incidents were the leading cause of occupational death in MVT, accounting for 37% of towing deaths overall (Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019, 2011, 2017). Most victims of pedestrian struck-by incidents were loading or securing vehicles for transport on the traffic-facing side of the vehicle when they were struck, an activity that is particularly dangerous because it requires the tow truck operator to work with their back turned to approaching traffic. Others were struck as they were climbing into or out of their cab.

These incidents illustrate the hazards tow truck operators face when performing complex movements in narrow roadside spaces, often within inches of moving traffic. Initiatives like the "Move Over" law are designed to protect first responders in such situations, but inconsistencies in how the law is applied and publicly understood may continue to leave tow truck operators at risk of being struck. Now adopted in all 50 states, the Move Over law requires motorists to change lanes or slow down when approaching a stopped first responder vehicle with its lights engaged (National Highway Traffic Safety Administration, U.S. Department of Transportation. Move Over. It's the Law. Accessed. https://www.nhtsa.gov/staticfiles/communications/pdf/MoveOver_QA.pdf. Accessed May 18, 2019, 2019). However, even though tow truck operators likely spend more time in this hazardous space and have elevated mortality rates relative to other first responders, not all states include them under this law. Further, the motoring public is generally unaware of the law—the National Highway Traffic Safety Administration reports that 71% of drivers are unaware that the law exists (National Highway Traffic Safety Administration, U.S. Department of Transportation. Move Over. It's the Law. Accessed. https://www.nhtsa.gov/staticfiles/communications/pdf/MoveOver_QA.pdf. Accessed May 18, 2019, 2019), and media reports indicate that those who are familiar with the law may not realize that their state extends the protections to include tow truck drivers (Geico, 2019; Little, 2019). To prevent future incidents, states should include tow truck operators in their Move Over statutes and actively promote public awareness that the law covers all first responders, including tow truck operators.

One in four cases were grouped under the 'caught-in or -between' event type domain, which mostly involved the victim being pinned beneath a load when it unexpectedly rolled or shifted and fell. It was notable that a failure to set wheel chocks and engage the load's parking brake were identified as primary causal factors in several of the 'caught-in or -between' investigations, particularly when unloading a vehicle at its destination. Lack of wheel chocking was also identified as a casual factor in several of the incidents in the 'struck by' event type domain, mostly when the victim was working to disengage the drive shaft from beneath the vehicle. The national towing certification curriculum by the National Towing and Recovery Association of American (TRAA) strongly urges chocking to secure the stability of a load and thus prevent injury (Towing and Recovery Association of America, 2019). While FMCSA mandates chocking for the transportation industry, there are no specific rules for MVT for chocking disabled vehicles prior to loading or unloading (Federal Motor Carrier Safety Administration, U.S. Department of Transportation. Standards for parking brake systems under 49 CFR § 393.41. Accessed. https://www.fmcsa.dot.gov/regulations/title49/section/393.41. Accessed April 15, 2019, 2019). Regulatory agencies should collaborate with the input of towing professionals to establish clear and effective rules around chocking that is specific to MVT. Until then, towing employers should implement chocking policies to protect workers, their clients, and others in the tow operator's workspace.

Notable were 'caught-in or -between' cases where victims entered the space beneath a raised vehicle when it fell, pinning them to the ground. Two fatal incidents were attributed to operating controls while under a raised vehicle in an attempt to unload the vehicle. One victim was using a remote lift control while beneath the raised vehicle, while the other used fixed lift controls with one hand while reaching for the tow chain beneath a raised truck with another. Industry safety experts strongly advise against raising or lowering a boom while the truck is loaded and recommend leaving remote controls locked in the vehicle until they are ready to be used (Guide; Towing and Recovery Association of America, 2019). One citation was issued in violation of 29 CFR 1910.184(c)(9), which requires that all employees be kept clear of loads that are either suspended or about to be suspended. However, TRAA curriculum urges against entering the space beneath a raised vehicle "unless it is completely stable and supported by safety stands." (Towing and Recovery Association of America, 2019) Alignment of federal standards and industry guidance regarding suspended loads is needed, and industry-specific regulations around raised loads may be needed for the MVT industry.

While the high number of pedestrian stuck-by incidents was somewhat expected, the identification of disengaging the drive shaft from beneath the vehicle as a hazardous activity was surprising. Injury narratives described drive shafts falling and striking victims in the head as well as the vehicle rolling and striking the driver as they were disengaging the drive shaft from beneath the vehicle. Other scenarios included the victim working to disengage the drive shaft when the vehicle shifted from its supports and fell on the victim. As a preventive measure, towing establishments should train tow truck operators to never work on a drive shaft without first ensuring that the vehicle is on a level surface, is properly chocked, and that both the drive shaft and vehicle are properly supported during disengagement (Towing and Recovery Association of America, 2019).

The Federal Highway Administration (FHWA) requires that all workers performing work within the right-of-way on highways who are exposed to traffic wear a fluorescent safety vest that meets American National Standards Institute (ANSI) standards (Federal Highway Administration, U.S. Department of Transportation. Standards for worker visbility under 23 CFR 634.3. Accessed. https://www.govinfo.gov/app/details/CFR-2009-title23-vol1/CFR-2009-title23-vol1-part634. Accessed March 1, 2019, 2019). Yet, for cases in which HVSA information was available, only about half of the victims were compliant. While reviews of workplace safety

policies generally indicated that reflective PPE was to be used, the policy was typically described as being loosely enforced. Some investigators of pedestrian struck-by incidents noted that a HVSA vest was found unused in the tow truck cab. This is an injury risk factor, considering that just over half of those struck by approaching traffic were struck during dark or low-light hours, and 4 in 10 were struck during partly cloudy to mostly cloudy conditions. Low-light conditions and the absence of high-visibility apparel are factors that increase pedestrian struck-by incident risk and severity (Haleem, Alluri, & Gan, 2015; Pour-Rouholamin & Zhou, 2016). Although HVSA is intended to increase the visibility of workers in both daytime and nighttime conditions, research has shown that workers may decide to not wear them if they find them to be uncomfortable or if perceived to reduce task efficiency (Chen, Chen, & Wang, 2014; Dorman & Havenith, 2009; Song & Kim, 2015). Despite design advancements in flexibility and comfort that meet the occupational needs of police work, studies have shown that many law enforcement officers rarely wear their HVSA, a trend that is impacted by officer attitudes towards HVSA and mediated by improvements to organizational safety culture and training (LaTourrette, Peterson, Bartis, Jackson, Houser, & Volume, 2003; Nisenson A, Kubu B, Carney A. Evaluation of Reflective Vest Options. Washington, DC: U.S. Department of Justice; April 2011, 2011; Song & Kim, 2015). It is possible that similar attituded, experiences and perceptions affect nonuse of HVSA in MVT.

Pedestrian struck-by incident cases also frequently noted the absence of portable emergency warning devices at the incident scene. Federal regulation (49 CFR § 392.22(b)) requires that commercial motor vehicle operators engage their emergency lights and employ safety warning devices (e.g., reflective triangles, cones, flares) any time they are stopped on a highway's travel lane shoulder (Federal Motor Carrier Safety Administration). However, the placement of warning devices itself can be a risky task, and the requirements of placing warning devices at 10 feet, 100 feet, and 200 feet toward approaching traffic may not be best suited for tow truck operators who routinely work alone at roadside. Future regulatory decisions should consider providing tailored specifications for warning device placement based on input from current tow truck drivers that addresses tow truck operator concerns about roadside exposure to traffic while setting warning devices.

5. Limitations

There are several limitations related to this study. To start, this study was based on a case series that may not represent overall MVT injuries that occur nationwide so the study results should be interpreted with caution. The number of cases identified in IMIS database were far fewer than those reported by BLS. For instance, CFOI data for 2011–2017 alone indicates there were 231 fatalities in MVT, 86 of which were pedestrian struck-by incidents. By contrast, we initially only identified 141 investigation abstracts for fatal and nonfatal injuries combined for a time span that was nearly twice as long (2002–2017). IMIS had no investigation records for 21 states, so geographic distribution is also a limitation. This discrepancy is likely due to jurisdiction and laws around reporting. Unlike most work-related incidents, those occurring on public roads are not required to be reported immediately to OSHA (Occupational Safety and Health Administration, U.S. Department of Labor. Standards for recording and reporting occupational injuries and illness under 29 1904, 1904), and OSHA often defers to law enforcement to investigate such incidents. Although establishments are still required to report such instances in their incident logs, the underreporting of occupational injuries is well-documented in the literature (Fagan & Hodgson, 2017; Leigh, Marcin, & Miller, 2004; Rosenman et al., 2006; Spieler & Wagner, 2014). Consequently, OSHA may never be aware of many injuries that may warrant investigation. Injuries not occurring on highways are also likely undercounted due to changes in reporting rules. Prior to 2015, serious injuries were only required to be reported if they resulted in the hospitalization of three or more employees. Despite this clear limitation, IMIS is the most comprehensive publicly-accessible repository of data available for injuries in MVT, and this study is the first the authors are aware of to analyze that data.

Additionally, narrative text coding is limited to the accuracy, consistency and completeness of available text data in the IMIS abstracts and investigation reports (Lincoln et al., 2004; Lombardi, Pannala, & Sorock, 2005). While informative, the investigation summary abstracts found in IMIS are shorter than thus provide less contextual information than what is typically found in full investigation reports. The authors obtained full investigation reports for only 39% of the cases. Because full investigation reports were not provided for most cases, narrative text coding categorization was broader for some variables. For instance, IMIS summary abstracts for pedestrian struck-by incidents would often only indicate that the victim was engaged in loading procedures at the time of the incident, while the full investigation reports for those same cases would more precisely describe the step of the loading process (e.g., securing straps, operating winch controls). Further, full IMIS reports provided more consistent detail regarding location and positioning of the victim at the incident time.

Another limitation exists in the method for collecting roadway characteristics. Although users may choose the year of the Google Maps Street View capture, it is typically not possible know whether roadway conditions or configurations may have differed on the exact date of the incident (e.g., speed limits, number of lanes, presence of roadway construction) unless explicitly described in the investigation abstract or reports.

6. Conclusion

MVT is an industry at high risk for mortality, with fatality rates that are significantly greater than other first responders. Establishments should ensure the safety of tow truck operators by providing written safety programs that include initial and refresher training on safe loading and unloading of disabled vehicles, defensive techniques when working near traffic, proper wheel chocking and braking procedures, and handling of drive shafts. Future regulatory decisions should be specified to address the unique challenges in MVT and developed with the direct input of tow truck drivers and MVT safety experts. States should include tow trucks as first responder vehicles in their "Move Over" laws, and mount aggressive public awareness campaigns urging motorists to yield road space to all first responders, including tow truck operators. To further identify target areas for interventions, future research should identify fatal and nonfatal injury incidence by demographics, event or exposure, primary source or injury, body part of injury, and victim location at the time of the incident.

Funding

The research and preparation of this document were conducted by researchers with the Kentucky Fatality Assessment and Control Evaluation (KY FACE) Program. Funding for the KY FACE Program is provided by the National Institute for Occupational Safety and Health (NIOSH) Cooperative Agreement Number 5U60OH008483-13. NIOSH had no role in the study design; in the collection, analysis or interpretation of data; in the writing of the report; nor in the decision to submit the article for publication. Otherwise, the authors confirm that there are no known conflicts of interest asso-

ciated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

References

Blodgett, D. W., Suruda, A. J., & Crouch, B. I. (2001). Fatal unintentional occupational poisonings by hydrofluoric acid in the U.S. *American Journal of Industrial Medicine, 40*(2), 215–220. https://doi.org/10.1002/ajim.1090.

Brown, D. E. (2016). Text mining the contributors to rail accidents. *IEEE Transactions on Intelligent Transportation Systems, 17*(2), 346–355. https://doi.org/10.1109/TITS.2015.2472580.

Bunn, T. L., Slavova, S., Chandler, M., Hanner, N., & Singleton, M. (2018). Surveillance of traffic incident management–related occupational fatalities in Kentucky, 2005–2016. *Traffic Injury Prevention, 19*(4), 446–453. https://doi.org/10.1080/15389588.2018.1432042.

Bureau of Labor Statistics, U.S. Department of Labor. Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity. Accessed. https://www.bls.gov/cps/cpsaat18.htm. Accessed March 15, 2019.

Census of Fatal Occupational Injuries (2011 forward) (Area: All U.S., Case Type: Fatalities in all sectors, Event or exposure: Pedestrian vehicular incident, Industry: Police protection) [database online]. Washington, DC: Bureau of Labor Statistics, U.S.

Chandler, M. D., Bunn, T. L., & Slavova, S. (2017). Narrative and quantitative analyses of workers' compensation-covered injuries in short-haul vs. long-haul trucking. *International Journal of Injury Control and Safety Promotion, 24*(1), 120–130. https://doi.org/10.1080/17457300.2016.1170041.

Chen, T. H., Chen, W. P., & Wang, M. J. J. (2014). The effect of air permeability and water vapor permeability of cleanroom clothing on physiological responses and wear comfort. *Journal of Occupational and Environmental Hygiene, 11*(6), 366–376. https://doi.org/10.1080/15459624.2013.875181.

Chua, D. K. H., Goh, Y. M. Incident causation model for improving feedback of safety knowledge. Journal of Construction Engineering and Management. 2004;130(4). doi: 10.1061/(ASCE)0733-9364(2004)130:4(542).

Dorman, L. E., & Havenith, G. (2009). The effects of protective clothing on energy consumption during different activities. *European Journal of Applied Physiology, 105*(3), 463–470. https://doi.org/10.1007/s00421-008-0924-2.

Fagan, K. M., & Hodgson, M. J. (2017). Under-recording of work-related injuries and illnesses: An OSHA priority. *Journal of Safety Research, 60*, 79–83. https://doi.org/10.1016/j.jsr.2016.12.002.

Fatal occupational injuries by selected worker characteristics and selected industry, All U.S., private industry (Years: 2011–2017) [database online]. Washington, DC: Census of Fatal Occupational Injuries, U.S. Department of Labor. https://data.bls.gov/gqt/RequestData/. Accessed February 10, 2019.

NIOSH. Fatality Assessment and Control Evaluation (FACE) Program. Accessed. https://www.cdc.gov/niosh/face/. Published 2019. Accessed August 22, 2019.

Federal Highway Administration, U.S. Department of Transportation. Standards for worker visibility under 23 CFR 634.3. Accessed. https://www.govinfo.gov/app/details/CFR-2009-title23-vol1/CFR-2009-title23-vol1-part634. Accessed March 1, 2019.

Federal Motor Carrier Safety Administration, U.S. Department of Transportation. Standards for emergency warning devices under 49 CFR § 392.22. Accessed. https://csa.fmcsa.dot.gov/safetyplanner/MyFiles/SubSections.aspx?ch=23&sec=68&sub=168.

Federal Motor Carrier Safety Administration, U.S. Department of Transportation. Standards for parking brake systems under 49 CFR § 393.41. Accessed. https://www.fmcsa.dot.gov/regulations/title49/section/393.41. Accessed April 15, 2019.

Geico. GEICO reminds drivers to move over for tow trucks, too. Accessed. https://www.geico.com/about/pressreleases/2018/20180831/. Accessed March 28, 2019.

Goh, Y. M., & Ubeynarayana, C. U. (2017). Construction accident narrative classification: An evaluation of text mining techniques. *Accident Analysis and Prevention, 108*, 122–130. https://doi.org/10.1016/j.aap.2017.08.026.

Guide FS. Tow Operations Fleet Safety Guide.

Haleem, K., Alluri, P., & Gan, A. (2015). Analyzing pedestrian crash injury severity at signalized and non-signalized locations. *Accident Analysis and Prevention, 81*, 14–23. https://doi.org/10.1016/j.aap.2015.04.025.

Henn, S. A., Bell, J. L., Sussell, A. L., & Konda, S. (2013). Occupational carbon monoxide fatalities in the US from unintentional non-fire related exposures, 1992–2008. *American Journal of Industrial Medicine, 56*(11), 1280–1289. https://doi.org/10.1002/ajim.22226.

Higgins, D., Casini, V. J., Bost, P., Johnson, W., & Rautiainen, R. (2001). The Fatality Assessment and Control Evaluation Program's role in the prevention of occupational fatalities. *Injury Prevention, 7*(Suppl 1), 27–33. https://doi.org/10.1136/ip.7.suppl_1.i27.

LaTourrette, T., Peterson, D. J., Bartis, J. T., Jackson, B. A., Houser, A. Protecting Emergency Responders Volume 2: Community Views of Safety and Health Risks and Personal Protection Needs. Arlington, VA: RAND. 2003. https://www.rand.org/pubs/monograph_reports/MR1646.html.

Leigh, J. P., Marcin, J. P., & Miller, T. R. (2004). An estimate of the U.S. Government's undercount of nonfatal occupational injuries. *Journal of Occupational and Environmental Medicine, 24*(4), 254–259. https://doi.org/10.1097/01.jom.0000105909.66435.53.

Lincoln, A. E., Sorock, G. S., Courtney, T. K., Wellman, H. M., Smith, G. S., & Amoroso, P. J. (2004). Using narrative text and coded data to develop hazard scenarios for occupational injury interventions. *Injury Prevention, 10*(4), 249–254. https://doi.org/10.1136/ip.2004.005181.

KHQA. Little known fact, tow trucks included in "Move Over" law. Accessed. https://khqa.com/news/local/little-known-fact-tow-trucks-included-in-move-over-law. Accessed March 15, 2019.

Lombardi, D. A., Pannala, R., Sorock, G. S., et al. (2005). Welding related occupational eye injuries: A narrative analysis. *Injury Prevention, 11*(3), 174–179. https://doi.org/10.1136/ip.2004.007088.

Lowe, B. D., Albers, J. T., Hudock, S. D., & Krieg, E. F. (2016). Serious injury and fatality investigations involving pneumatic nail guns, 1985–2012. *American Journal of Industrial Medicine, 59*(2), 164–174. https://doi.org/10.1002/ajim.22560.

McKenzie, K., Scott, D. A., Campbell, M. A., & McClure, R. J. (2010). The use of narrative text for injury surveillance research: A systematic review. *Accident Analysis and Prevention, 42*(2), 354–363. https://doi.org/10.1016/j.aap.2009.09.020.

National Highway Traffic Safety Administration, U.S. Department of Transportation. Move Over. It's the Law. Accessed. https://www.nhtsa.gov/staticfiles/communications/pdf/MoveOver_QA.pdf. Accessed May 18, 2019.

Nisenson A, Kubu B, Carney A. Evaluation of Reflective Vest Options. Washington, DC: U.S. Department of Justice; April 2011. Accessed. https://www.ncjrs.gov/pdffiles1/nij/grants/234134.pdf.

Nonfatal cases involving days away from work: selected characteristics (2011 forward) (Years: 2011-2017) [database online]. Washington, DC: Survey of Occupational Injuries and Illnesses, U.S. Department of Labor. https://data.bls.gov/PDQWeb/cs. Accessed February 10, 2019.

Occupational Safety and Health Administration, U.S. Department of Labor. State Plans. Accessed. https://www.osha.gov/dcsp/osp/. Accessed March 3, 2019.

Owens, N., Armstrong, A., Sullivan, P., et al. (2010). *Traffic Incident Management Handbook*. McLean, VA: Science Applications International Corporation (SAIC). doi: 10.1093/her/cys022.

Owner of Towing Company Dies When Struck by Driver of a Box Truck (Report No. 2012-KY-035). Kentucky FACE Program, KIPRC. Lexington, KY; 2014. Accessed. http://www.mc.uky.edu/kiprc/projects/KOSHS/face/data/Reports/Case-Fatality-Report-12KY035.pdf. Accessed March 3, 2019.

Pedestrian Tow Truck Operator Struck and Killed by Drunk Driver While Rendering Assistance on Highway Roadside (Report No. 2014-KY-033). Kentucky FACE Program, KIPRC. Lexington, KY; 2014. Accessed. https://www.cdc.gov/niosh/face/pdfs/14Ky033.pdf. Accessed March 3, 2019.

Pour-Rouholamin, M., & Zhou, H. (2016). Investigating the risk factors associated with pedestrian injury severity in Illinois. *Journal of Safety Research, 57*, 9–17. https://doi.org/10.1016/j.jsr.2016.03.004.

Rosenbaum, S., & Berger, M. (2011). The Freedom of Information Act: Implications for public health policy and practice. *Public Health Reports, 126*(3), 428–432. https://doi.org/10.1177/003335491112600317.

Rosenman, K. D., Kalush, A., Reilly, M. J., Gardiner, J. C., Reeves, M., & Luo, Z. (2006). How much work-related injury and illness is missed by the current national surveillance system? *Journal of Occupational and Environmental Medicine, 48*(4), 357–365. https://doi.org/10.1097/01.jom.0000205864.81970.63.

Occupational Safety and Health Administration, U.S. Department of Labor. Standards for recording and reporting occupational injuries and illness under 29 1904.39(b)(4). Accessed. https://www.osha.gov/laws-regs/regulations/standardnumber/1904/1904.39. Accessed March 16, 2019.

Occupational Safety and Health Administration, U.S. Department of Labor. Updates to OSHA's Recordkeeping Rule: Reporting Fatalities and Severe Injuries. Accessed. https://www.osha.gov/recordkeeping2014/OSHA3745.pdf. Accessed March 18, 2019.

Sayler, S. K., Roberts, B. J., Manning, M. A., Sun, K., & Neitzel, R. L. (2019). Patterns and trends in OSHA occupational noise exposure measurements from 1979 to 2013. *Occupational and Environmental Medicine, 76*(2), 118–124. https://doi.org/10.1136/oemed-2018-105041.

Siddiqui S. U.S. construction worker fall accidents: Their causes and influential factors. [Master's Thesis]. Miami, FL: Florida International University; 2014. doi:10.25148/etd.FI14040808.

Song, S. Y., & Kim, Y. K. (2015). Law enforcement officers' high-visibility safety apparel: The effect of their attitudes on wearing behavior. *Journal of Textile and Apparel, Technology and Management, 9*(2), 1–18.

Spieler, E. A., & Wagner, G. R. (2014). Counting matters: Implications of undercounting in the BLS survey of occupational injuries and illnesses. *American Journal of Industrial Medicine, 57*(10), 1077–1084. https://doi.org/10.1002/ajim.22382.

Tow Truck Driver Dies When Pinned Under Car (Report No. 2008-MI-095). Michigan FACE Program, Michigan State University (MSU). East Lansing, Michigan; 2008. Accessed. https://www.cdc.gov/niosh/face/stateface/mi/08mi095.html. Accessed March 3, 2019.

Tow Truck Driver Struck and Killed by Passenger Vehicle While Securing Disabled Vehicle onto Flatbed Tow Truck (Report No. 2016-KY-052). Kentucky FACE Program, KIPRC. Lexington, KY; 2016. Accessed. http://www.mc.uky.edu/kiprc/face/reports/pdf/16KY052.pdf. Accessed March 3, 2019.

Tow Truck Driver Struck and Killed by Van While Entering His Tow Truck (Report No. 2016-KY-055). Kentucky Fatality Assessment and Control Evaluation (FACE) Program, Kentucky Injury Prevention and Research Center (KIPRC). Lexington, KY; 2017. Accessed. http://www.mc.uky.edu/kiprc/face/reports/pdf/16KY055.pdf. Accessed March 3, 2019.

Tow Truck Helper Run Over While Unloading a Car from a Flatbed Truck in New Jersey (Report No. 1999-NJ-091). New Jersy FACE Program, NJ Department of Health & Senior Services. Trenton, NJ; 1999. Accessed. https://www.nj.gov/health/workplacehealthandsafety/documents/fatal-injuries/99nj091.pdf. Accessed March 3, 2019.

Tow Truck Operator Fatally Injured When Struck by a Box Truck While Assisting a Motorist – Massachusetts (Report No. 2015-MA-007-01). Massachusetts FACE Program, Massachusetts Department of Public Health. Boston, MA; 2015. Accessed. https://www.cdc.gov/niosh/face/pdfs/15ma007.pdf. Accessed March 3, 2019.

Towing and Recovery Association of America. National Driver Certification Program - Master Tower. Accessed. https://www.towproservices.com/uploads/2/7/8/8/2788635/traa.level_1_study_guide.pdf. Accessed April 19, 2019.

Towman Crushed To Death While Hooking Up Disabled Propane Truck (Report No. 2001-IA-002). Iowa FACE Program, University of Iowa. Iowa City, Iowa; 2001. Accessed. https://www.cdc.gov/niosh/face/stateface/ia/01ia002.html. Accessed March 3, 2019.

U.S. Department of Justice. The Freedom of Information Act. 1966. https://www.justice.gov/oip/freedom-information-act-5-usc-552. Accessed March 5, 2019.

Vallmuur, K., Marucci-Wellman, H. R., Taylor, J. A., Lehto, M., Corns, H. L., & Smith, G. S. (2016). Harnessing information from injury narratives in the 'big data' era: Understanding and applying machine learning for injury surveillance. *Injury Prevention*. https://doi.org/10.1136/injuryprev-2015-041813.

Yamin, S. C., Bejan, A., Parker, D. L., Xi, M., & Brosseau, L. M. (2016). Analysis of workers' compensation claims data for machine-related injuries in metal fabrication businesses. *American Journal of Industrial Medicine, 59*(8), 656–664. https://doi.org/10.1002/ajim.22603.

Mark D. Chandler received his Master of Public Health from the University of Kentucky. His background has heavily focused on occupational injury epidemiology, risk communication, and the development of occupational safety training resources. He formerly served as the Project Manager of the Kentucky Occupational Safety and Health Surveillance (KOSHS) Program at the Kentucky Injury Prevention and Research Center—a NIOSH-funded program to conduct occupational safety and health surveillance to address hazards faced by Kentucky workers. He currently serves as a Research Associate for Safe Kids Worldwide in Washington, DC where he conducts research and program evaluation to support childhood injury prevention initiatives.

Dr. Terry L. Bunn received her doctorate from Cornell University, and is an Associate Professor in the Department of Preventive Medicine and Environmental Health at the University of Kentucky, College of Public Health. She has been the Director of the Kentucky Injury Prevention and Research Center (KIPRC) since 2010. Dr. Bunn conducts research in the prevention of motor vehicle injuries and of drug poisonings, in both the general and working populations.