Fatal and Non-Fatal Injuries From Vessels Under Air Pressure in Construction

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Using a surveillance system that captures data on construction workers treated in an urban emergency department, we identified a series of injuries caused by vessels and tools under air pressure. We describe those six cases, as well as similar cases found in the Census of Fatal Occupational Injuries; we also review data from the National Surveillance for Traumatic Occupational Fatalities database and data from the Bureau of Labor Statistics. Among the injuries and deaths for which we had good case descriptions, the majority would have been prevented by adherence to existing Occupational Safety and Health Administration standards in the construction industry.

Construction work is dangerous, with high rates of both fatal and non-fatal injuries. Seventeen percent of all fatal on-the-job injuries occur in construction: approximately three times its 6% share of total private-sector employment.[1] Half of all fatal falls occur in construction.[1] Construction also has a high rate of non-fatal injuries. In 1996 there were 4.5 lost-time injuries per 100 full-time equivalent construction workers, compared with a rate of 3.4 per 100 full-time equivalent workers in all private industry; this rate exceeded that of all other sectors except transportation.[2] The overall recordable injury rate in construction was 9.9 per 100 full-time equivalent workers in 1996, second only to that of the manufacturing industry.[2] In addition, data from the Bureau of Labor Statistics may underestimate the rate in construction workers. For example, Lipscomb et al[3] reported a rate of medical cost or lost-time compensation claims among carpenters of 43.7 per 200,000 work hours. Glazner et al[4] reported fatal injury rates for a large airport construction project that were twice as high as those published by the BLS for the construction industry during the same years.

We have known for years that the construction industry has high rates of fatal and non-fatal injuries, compared with other industries, but knowing general patterns of injuries is not enough to identify opportunities for prevention. In order to prevent or reduce the risk of injury in construction, we must understand the cause of injuries in detail.

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Since 1990, we and our colleagues at George Washington University (GWU) have been abstracting information from the medical records of over 3000 construction workers seen at the George Washington University Emergency Department[5] and have used these data to describe patterns of injury. We have conducted several follow-up studies to investigate the causes of and impairment from eye injuries, musculoskeletal injuries, and falls. We have found that analyses by trade and by type of injury have pointed to many specific opportunities to reduce injury.[6]

Through this surveillance system, we identified one death and five non-fatal injuries to construction workers caused by explosion of a pressurized vessel, hose, or other equipment. In this article, we report on those cases and on fatalities from a similar cause among construction workers identified using data from the National Surveillance for Traumatic Occupational Fatalities (NTOF) and the Census of Fatal Occupational Injuries (CFOI). By examining these cases, we identified mechanisms to prevent such injuries in the future.

Fatal Cases

Index Case

GWU Case No. 1. On June 2, 1992, a worker engaged in a sandblasting operation was killed when the cover on a pressurized vessel blew off and hit him in the head, killing him instantly. The pressurized blast pot is used to send pressure to the sandblasting hose, then used as a collection vessel when the system is reversed, and used as a vacuum for cleaning the area after blasting. To reverse the system, the pressure is turned off, the blast pot opened, the hoses reversed, and the pressure turned on again. The worker climbed on top of the blast pot and loosened the victaulic access fittings that secured the access panels, without having shut down the pressure. He had performed this operation numerous times before without making this error. There was no safety mechanism on the blast pot to prevent its opening while under pressure.

Other Fatal Injuries From Vessels Under Air Pressure in Construction

The NTOF is a surveillance system of work-related deaths that is maintained by the National Institute for Occupational Safety and Health and which extends back to 1980. NTOF data are based on a census of death certificates collected from the vital statistics registrars of 50 states, New York City, and the District of Columbia. Cases are included if the victim is at least 16 years of age, the death is due to an external cause of death, and the "injury at work" box is marked "yes."

From 1980 to 1992, there were at least 65 deaths in the construction industry with a cause of death classified as related to pressurized vessels (E-code = 921.0). We were particularly interested in cases similar to our index case, so we restricted this analysis to vessels pressurized with air. By using the narrative injury description, ten cases were classified as related to gas cylinders, 11 were related to boilers, 18 were due to explosion of a tire, and three involved pipelines. The remaining 23 deaths were either clearly related to a tank or compressor under pressure (nine cases), or did not have sufficient information for identification of the exact source (14 cases). The injury narratives did not have enough detail for identification of the task or activity of the worker at the time of the incident. Therefore, from 1980 to 1992, NTOF identified between nine and 23 cases similar to our index case.

The BLS CFOI for 1992 to 1996 extends this series. This data set, which has supplanted the NIOSH NTOF system, uses Occupational Safety and Health Administration and workers' compensation case records, death certificates, and other sources (eg, newspaper reports) to compile information about fatal occupational injuries. This data set includes basic demographic information about each worker and the Standardized Industrial Classification and Standardized Occupational Classification codes used by the BLS. The BLS has developed a code structure that assigns each fatality a code for the following variables: the worker's activity at the time of the incident, the nature of injury, the body part affected, the type of event, and the source of injury in each fatality.

Selection criteria. A case from CFOI was included in this case series if the source of the injury was classified as a pressurized container, hose, or line or was classified as pressurized, not elsewhere classified (n.e.c.) (source code = 1200, 1220, 1240, or 1290) and if the event was an unspecified explosion, n.e.c. (event code = 5200, 5220, or 5290). Explosions of boilers, gas cylinders, and hydraulic lines were excluded, as were explosions that resulted from fuel ignition. From 1992 to 1996, there were four fatalities among construction workers that fit these selection criteria, in addition to the index case above.

These fatalities occurred as follows:

CFOI Case No. 1. A construction laborer was testing a sewer pipe with compressed air. He released a valve to hurry the process and the pressure released suddenly, throwing the worker and causing fatal injuries to multiple body parts.

CFOI Case No. 2. A plumber/pipefitter was inspecting a line with 1500 psi (presumed air) pressure. He was seeking the source of a leak, and when he attempted to close a valve, it exploded, nearly decapitating him.

CFOI Case No. 3. A supervisor was removing a catalyst from a reactor vessel that had been overpressurized with nitrogen. When he broke through a crust at the top of the

vessel, it exploded, causing multiple head injuries.

CFOI Case No. 4. A welder was cutting up scrap metal when a tank he was using lost its pressure. A replacement tank was brought, which exploded, inflicting multiple head injuries.

Non-Fatal Injuries From Vessels Under Air Pressure in Construction

We also reviewed data sources to find similar cases among non-fatal injuries. The BLS data on non-fatal injuries do not contain sufficient detail to allow identification of these cases, so we report data from our case series at GWU. (A revised OSHA record-keeping data set should collect such data.)

GWU Case No. 2. On February 03, 1996, a 41-year-old male carpenter was injured when the pressurized pellet gun he was using exploded in his hand. The explosion resulted in his left hand being punctured with a foreign body. The man fell 4 to 5 feet off a ladder as a result of the explosion.

GWU Case No. 3. On April 12, 1997, a 26-year-old male construction laborer sustained a leg contusion and a knee laceration when a 250-psi air compressor hose exploded and he was struck by a metal fitting.

GWU Case No. 4. On November 16, 1995, a 39-year-old male construction laborer was injured when a high-pressure hose came loose and struck him in the leg. He sustained a contusion and abrasion to his left leg.

GWU Case No. 5. On November 3, 1994, a 33-year-old male construction laborer was injured when an air hose came loose from the jackhammer that he was using. The rubber hose remained attached to the compressor and struck the man's inner thigh. The victim tried to run out of the way of the hose but ran straight into a scaffold, injuring his left testicle. He was treated in the emergency department for traumatic epididymitis.

GWU Case No. 6. On June 29, 1992, a 41-year-old male construction worker (trade not otherwise specified) was injured when an air hose came loose from the jackhammer that he was using. The air hose remained attached to the compressor and struck the man in the mid-back region and right leg. The victim suffered from back pain, an abrasion over the lumbar spine area, and a hematoma over the right tibia.

Discussion

Use of pneumatic devices in construction entails a special hazard that warrants specific training and guidelines or regulations on use and maintenance of equipment. These cases illustrate that the power inherent in a pneumatic device can seriously injure or kill a worker.

There have been a few reports of occupational injuries to the hand or eye caused by hand tools driven by air pressure. Ballal[7] reported on eye injuries caused by the use of a pneumatic chisel. Childs[8] presented a case of a traumatic penetrating wound caused by the force of compressed air; Stroh and Finger[9] described a similar injury to the eye from the force of air under pressure. Injection of paint into the hand from use of a pneumatic paint gun has been described.[10–13] We found no reports of injuries caused by exploding vessels.

An OSHA investigation of the fatality described in Case No. 1 determined that the vessel was not in compliance with existing standards, which require that any pressurized vessel have the following safeguards:

(1) Closure is fully engaged before pressure can build up in the vessel.
(2) Pressure tending to force the closure clear of the vessel will be released before the closure can be fully opened.
(3) Provisions are made so that devices to accomplish this can be added when the vessel is installed, in the event that compliance with (1) and (2) is not inherent in the design of the closure and its holding elements.
(4) Closures that do not satisfy (1), (2) and (3) above must be equipped with an audible and/or visible warning signal that will serve to warn the operator if an attempt is made to operate the locking mechanism before pressure in the vessel is released.

In Case No. 1, the access panel blew off as soon as the closures were open, demonstrating that (1) and (2) were not complied with, nor was there any warning signal to comply with (3).

Four of the five non-fatal injuries were due to injury from a pneumatic tool, in which the pneumatic hose came loose from the tool and struck the worker. OSHA also has a regulation (29 CFR 1926.302) that specifies elements of the design, operation, and maintenance of pneumatic power tools. Items that would specifically apply to these cases include:

29 CFR 1926.302(a)(2): Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tools from becoming accidentally disconnected.

29 CFR 1926.302(b)(7): All hoses exceeding ½ inch inside diameter shall have a safety device at the source of supply or branch line to reduce pressure in case of hose failure.

29 CFR 1926.302(e)(2): The tool shall be tested each day before loading to see that safety devices are in proper working condition. The method of testing shall be in accordance with the manufacturer's recommended procedure.

We do not know the details of the operations and maintenance procedure of the contractors, but four of these injuries clearly could not have happened if the above safeguards

were in place. The hand injury from the pellet gun is not addressed by these standards specifically and would require additional investigation to determine the cause of the injury and whether it could have been prevented by use of a different safety procedure or worker training.

Similar safety concerns apply to the use of hydraulically powered tools and equipment. Through our emergency department surveillance, we also identified a number of workers who were struck and injured by hydraulic hoses or metal fittings.

Worker and supervisor training is necessary for effective implementation of safety standards and procedures. The OSHA investigation of Case No. 1 determined that employees were specifically trained in lead abatement, but general safety meetings were not being held on that job site, and no documentation provided any evidence for a continuous site-safety program involving supervisors. We have no knowledge of training and safety programs for the sites at which the other injured workers were employed.

Each case alone might not suggest a pattern of injury, but looking at these cases together we see the hazards of using pneumatic devices in construction. The CFOI allowed us to find cases that were very similar to our index case, because of the improved data collection, coding, and injury narrative of that system. We were not able to find non-fatal cases, because BLS surveillance data do not include detailed injury descriptions.

On the basis of this case series, we have recommended increased training in the use of pneumatic tools and pressurized vessels and a specific focus on implementation of the existing OSHA standards that would have prevented a great majority of these injuries.

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