
Farm Workers Electrocuted When Irrigation Pipes Contact Powerlines

STEVEN D. HELGERSON, MD, MPH
SAMUEL MILHAM, Jr., MD, MPH

Dr. Helgerson is medical epidemiologist at the Seattle-King County Department of Public Health, Seattle; at the time of the study he was medical epidemiologist with the National Institute for Occupational Safety and Health, stationed at the Washington State Division of Health.

Tearsheet requests to Samuel Milham, Jr., MD, MPH, head of the epidemiology section, Division of Health, ET-13, Department of Social and Health Services, Olympia, WA 98504.

Synopsis

For accidental electrocutions in Washington State from 1950 to 1979, the standardized proportionate mortality ratio for farmers compared with the general population was found to be 226 in a recent report. This excess mortality rate in Washington State was investigated by the authors, who reviewed death certificates and associated local

newspaper reports of all farmers killed by electrocution during 1950-79 and of all persons killed by electrocution during 1970-79. Selected employers, next of kin, and public utility personnel were also interviewed.

In Washington State 42 farmers were electrocuted during the years 1950-79; 23 of them were killed while working near irrigation pipes that came into contact with overhead electrical lines. During 1970-79 there were 15 irrigation pipe-associated (IPA) electrocutions among farmers and 15 among farm workers. The average age of farmers who suffered IPA electrocutions, 33.2 years, was less than the average age of farmers whose electrocutions were not associated with irrigation pipes, 48.9 years. Among persons less than 20 years old, IPA electrocutions were more common than any other type of electrocutions. During the months of April through September, 93 percent of the IPA electrocutions occurred as compared with only 61 percent of other types of electrocution.

Among measures for the prevention of these electrocutions are education of the population at risk and changes in methods of irrigation.

FARMING IS A HAZARDOUS OCCUPATION. In 1979 farm workers died of job-related injuries at a rate exceeded only by that among workers in the mining and quarrying industry (1). Injuries are responsible for many farm workers' deaths, but few risk factors associated with these injuries have been described.

A recent completed analysis of occupational mortality in Washington State (2) indicated that farmers had a significant increase in mortality due to accidental electrocution when compared with nonfarmers (see table). To assess the causes of that excess, we studied the circumstances surrounding the electrocutions among farm workers in Washington State. We will describe the large proportion of electrocutions associated with handling irrigation pipes near high-voltage powerlines and consider ways to prevent these deaths.

Methods

The methods for calculating an occupation-specific proportionate mortality ratio (PMR) and the significance of results have been presented

elsewhere (2). The PMR has been standardized for age in 5-year age groups, sex, and single year of death. The death experience of male farmers was compared with that of all males 20 years of age or more in Washington State from 1950 to 1979. Modified codes of the U.S. Bureau of the Census were used to classify occupation (3).

Death certificates for all electrocutions among farmers for the years 1950-79 and for all electrocutions in Washington State for 1970-79 were reviewed. When the circumstances of the death were not clearly stated on the death certificate, further details were sought by perusing copies of local newspapers published shortly after the death. Deaths were considered to be due to irrigation pipe-associated (IPA) electrocution when the death certificate or newspaper article gave sufficient information to make that conclusion. We defined a death to be occupationally related when the death certificate specified that the injury occurred at work.

We visited two sites where three IPA electrocutions had occurred. The sites were selected because they were near each other and could be visited on

consecutive days. In addition, we interviewed relatives and one employer to learn the exact circumstances of death. The information in death certificate statements and newspaper reports was consistent with what we learned during the site visits.

Results

During the years 1950–79, 42 Washington State farmers were electrocuted, according to death certificate reports. If the farmers' experience had been consistent with that of the general population, there would have been approximately 18 electrocutions. The aggregate PMR, 226, and the PMR for each category of farmer are shown in the table. The

Electrocution deaths among farmers in Washington State, 1950–79

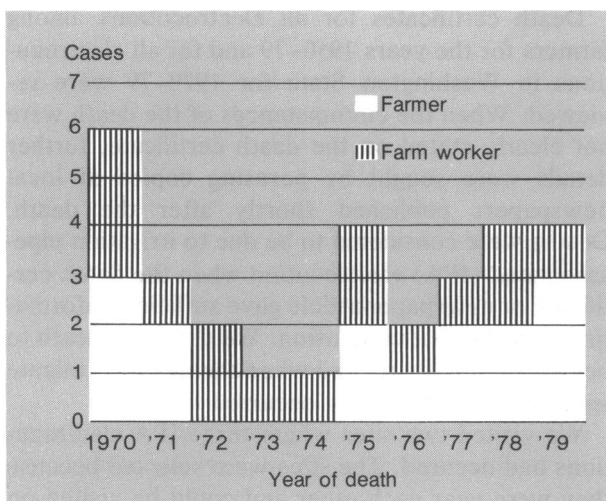
Occupation ¹	Total electrocution deaths			PMR ³	Irrigation pipe-associated electrocutions
	Observed deaths	Expected deaths	Excess deaths ²		
Farmer, general . . .	18	8	10	233	10
Farm laborer	9	5	4	168	7
Orchardist	3	1	2	231	2
Orchardist laborer . .	4	1	3	289	2
Nursery worker	2	<0.5	2	400	0
Rancher	3	1	2	236	1
Dairy farmer	1	1	0	97	0
Wheat farmer	2	1	1	136	1
Total	42	18	24	226	23

¹ Classified by modified U.S. Census Bureau occupational code.

² Number of observed minus number of expected deaths.

³ Standardized proportionate mortality ratio.

Irrigation pipe-associated electrocution deaths among farmers and farm workers by year of death, Washington State, 1970–79



numbers of IPA electrocutions and excess deaths due to electrocution were similar among farmers in general (23 and 24 deaths, respectively) and in most categories: farmers, general (10 IPA electrocutions and 10 excess deaths); farm laborers (7 and 4); orchardists (2 and 2); orchardist laborers (2 and 3); wheat farmers (1 and 1); and ranchers (1 and 2).

More IPA electrocutions occurred among farmers during the 1970s (15 deaths) than from 1950 to 1969 (8): in 1954, 3 deaths; 1955, 1; 1961, 1; 1964, 1; 1966, 2; 1970, 3; 1971, 2; 1975, 2; 1976, 1; 1977, 2; 1978, 2; and 1979, 3. As expected, the IPA electrocutions had a seasonal distribution, with 91 percent during the months of April through September. Eleven of the farmers suffering IPA electrocution were less than 30 years of age, 5 were 30–39, 4 were 40–49, and 3 were more than 50. The average age of farmers who suffered IPA electrocution, 33.2 years, was less than that of farmers whose electrocutions were not associated with irrigation pipes, 48.9 years ($P < 0.01$, t test).

Because IPA electrocutions among farmers were more frequent during the 1970s than from 1950 to 1969, we decided to review all 152 electrocutions of Washington State residents for the years 1970–79. Nineteen of the 152 electrocuted residents were previously identified farmers. We found 15 IPA electrocutions during 1970–79 among persons who were not male farmers 20 years of age or older and therefore had not been included in our definition of a farmer. We called this group farm workers to distinguish them from farmers. Ten of the farm workers were students, one of them a female, with an average age of 16 years. The numbers of IPA electrocutions of farmers and farm workers occurring each year during 1970–79 are shown in the figure.

IPA electrocutions during 1970–79 among farmers and farm workers can be distinguished from other electrocutions during those years on the basis of the geographic area, the time of year, and the age of the victims. Not surprisingly, IPA electrocutions usually occurred in rural areas during the months of planting and harvest. Ninety-three percent of IPA electrocutions (28 of 30) occurred from April through September, while only 61 percent of other electrocutions (75 of 122) occurred during those months ($P < 0.01$, χ^2 test). Forty-one percent of the non-IPA electrocutions (50 of 122) occurred in the urban counties of King, Pierce, and Spokane, compared with 7 percent of IPA electrocutions (2 of 30) ($P < 0.01$, χ^2 test). Seventy-seven percent of the IPA electrocutions (23 of 30) involved persons under 30 years of age, compared with only 39 per-

cent of non-IPA electrocutions (48 to 122) ($P < 0.01$, χ^2 test). In persons under 20 years old, IPA electrocutions were more common than any other type of electrocution (11 of 29, or 38 percent).

Death certificates for 89 of 152 persons electrocuted in 1970–79 (59 percent) specified that the lethal injury occurred at work. Most common among these occupational deaths were (a) IPA electrocutions involving farmers and farm workers, accounting for 18 of 89 deaths, or 20 percent, and (b) electrocutions caused by electrical lines contacting crane booms or other heavy equipment involving the equipment operators, also accounting for 18 deaths. The standardized proportionate mortality ratio for electrocution for the latter group for 1950–79 was 340 (2).

During the site visits we confirmed suspicions raised during review of death certificates and newspaper articles. Thirty- and forty-foot lengths of 3-inch aluminum irrigation pipe are designed so they can be moved by hand. During the growing season the segments of pipe are disconnected regularly, carried hundreds of feet across a field, reconnected, and then used to irrigate another section of the field. Electrocutions occur at the periphery of fields, where the electrical lines run and irrigation pipes are left after the field has been irrigated.

In accordance with the National Electrical Safety Code of the American National Standards Institute, the Washington State Safety Code requires electrical lines near roads in rural districts to be at least 18 feet above ground at their lowest point (4,5). Even when electrical lines fully meet this requirement, workers may contact them when tilting irrigation pipes up to clear out water, dirt, or small animals, or when moving the pipes among trees in orchards.

Discussion

In Washington State, irrigation pipes have been the most common source of fatal human contact with electrical lines. From 1970 to 1979, IPA electrocutions accounted for 20 percent of all electrocutions (30 to 152), 38 percent of electrocutions among persons under 20 years of age (11 of 29), 20 percent of work-related electrocutions (18 of 89), and 79 percent of electrocutions among farmers (15 of 19). During that same period, IPA electrocutions accounted for 1,191 years of potential life lost before age 65, an average of 39.7 years per person electrocuted. Potential years lost were calculated by adding the difference between age 65 and each

victim's age at death. The average number of years lost was calculated by dividing the total by the number of victims.

The increased number of IPA electrocutions among Washington farmers during the 1970s compared with preceding years was probably due to the expanding use of irrigation systems requiring electricity. From 1950 to 1970 irrigation systems evolved from gravity-dependent surface systems to electrically powered pump systems with overhead powerlines. The number of acres irrigated in the Columbia River Basin increased from 266,590 in 1959 to 446,596 in 1970, and the proportion of these acres irrigated by electrically powered systems increased from 25 percent to 44 percent. By 1979 the number of irrigated acres was 511,111, of which 60 percent was irrigated by electrically powered systems. The risk of farmers being exposed to overhead electrical lines when handling irrigation equipment had increased dramatically.

Because a death was defined as work related only when the death certificate specified that the injury occurred at work, the proportion of occupationally related IPA electrocutions may have been underestimated. Probably all 30 IPA electrocutions from 1970 to 1979, not just the 18 specified on death certificates, occurred at work. Therefore, the proportion of occupationally related IPA electrocutions may have been as high as 30 percent (30 of 101).

Possible measures to prevent these electrocutions include the following.

- *Place electrical lines out of reach of workers either by increasing the minimum height of the lines or by burying them.* If all electrical lines were at least 50 feet above the ground, a 6-foot-tall worker handling a 40-foot irrigation pipe would have to stand on something in order to contact the electrical line. It would be extremely expensive, however, to implement this measure. In Grant County alone there are more than 2,700 miles of electrical lines, of which at least 1,000 miles are adjacent to irrigated fields (personal communication, Fred Griffith, Public Utility District, Grant County, WA, August 26, 1982). A minimum height of 40 feet would necessitate taller and more expensive poles that would result in enormous expenses for labor as well as trucks with taller "cherry pickers" to service the lines.

Replacing existing electrical lines with underground lines would also be expensive. On the other hand, new powerlines used for irrigation systems should be installed underground. Many power companies offer cost-sharing programs that make no

additional charge for underground installation if the farmer agrees to dig and fill in the trench.

- *Decrease the length of hand-carried irrigation pipes.* Even if irrigation pipes were sold only in 20-foot lengths, they would require more labor to move across a field and more fittings to connect the segments, yet they could still reach electrical lines only 18 feet above the ground. In addition, thousands of miles of 30- and 40-foot lengths of irrigation pipe that can be carried by hand are currently owned by farmers, who will continue to use these pipes.

- *Change the method of irrigation.* Irrigation pipes on wheels, center-pivot irrigation systems, and "solid-set" pipes (buried pipes with sprinkler heads above the ground) may prevent many IPA electrocutions. Despite high initial costs, these methods are labor-efficient over time and are replacing the use of hand-carried irrigation pipes on large farms and orchards.

- *Regulate and inspect.* A Washington Department of Labor and Industries regulation requires that "no work shall be performed, no material shall be piled, stored or otherwise handled, no scaffolding, commercial signs, or structures shall be erected or dismantled, nor any tools, machinery or equipment operated within the specified minimum distance from any energized high voltage electrical conductor capable of energizing the material or equipment, unless workers are protected in accordance with this section." (6).

Like most regulations, this one can only be effective if enforced. There are too few inspectors to identify regularly farm areas where irrigation pipes are kept near powerlines and then advise farmers to move the pipes. Other regulations require that farm employers train employees about safety and that employees follow safety instructions of employers (7). We encourage employers and employees to regularly review and constantly observe safety measures such as avoiding contact with electrical lines.

- *Educate the population at risk.* Groups such as public utility companies and cooperative extension services have recognized the dangers of IPA electrocution and have advised caution when irrigation pipes are handled near electrical lines. For example, one public utility company sends an 8½ × 11-inch safety poster with monthly billing statements to every farm household (personal communication, Fred Griffith, Public Utility District of Grant County, WA, August 26, 1982). The posters are in both English and Spanish:

"LOOK UP AND LIVE. When cleaning or moving irrigation pipe, watch out for overhead powerlines. Handling irrigation pipe or other farm equipment underneath electrical powerlines can result in serious or fatal injuries. LOOK UP AND LIVE."

Safety information programs in public schools in rural areas have included discussions of the potential danger associated with handling irrigation pipes.

It is unlikely that public or private expenditures will support implementation of prevention measures such as placing electrical lines out of reach of workers or decreasing the length of hand-carried pipes. Irrigation methods are changing, but many farm workers will probably continue to irrigate with hand-carried pipes. Although the effectiveness of safety education in preventing injuries among farmers has been questioned (8), efforts to educate the population at risk for IPA electrocution should be expanded. All agencies and groups in rural areas irrigated with metal pipes should be encouraged to remind farm workers of the life-threatening hazard of IPA electrocution. Agencies and groups include State and county health departments, utility companies, agriculture extension services, school districts, civic associations, and agricultural worker groups. Public health investigators should monitor the effectiveness of the educational program in reducing the number of IPA electrocutions.

References

1. Accident facts, 1980. National Safety Council, Chicago, 1980.
2. Milham, S., Jr.: Occupational mortality in Washington State, 1950-1979. DHHS publication No. (NIOSH) 83-116. PB-84-199-769. National Technical Information Service, Springfield, VA, 1983.
3. U.S. Bureau of the Census: Classified index of occupations and industries, 1960 census of population. U.S. Government Printing Office, Washington, DC, 1960.
4. Washington Administrative Code, 296-44. Safety standards, electrical construction code. Statute Law Committee 6: 755 (1980).
5. National Safety Electrical Code, part 2, sections 20-28: Safety rules for the installation and maintenance of overhead supply and communication line. American National Standards Institute, New York, 1981.
6. Washington Administrative Code, 296-24. General safety and health standards. Statute Law Committee 5: 28 (1982).
7. Washington Administrative Code, 296-306. Labor and industries. Statute Law Committee 6: 1606 (1980).
8. Murphy, D. B.: Farm safety attitudes and accident involvement. *Accident Anal Prev* 13: 331-337 (1981).