Surveillance of Construction Worker Injuries Through an Urban Emergency Department

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To learn more about the causes of nonfatal construction worker injuries, and to identify injury cases for further work-site investigations or prevention programs, an emergency department-based surveillance program was established. Construction workers with work-related injuries or illnesses were identified by reviewing the medical records of all patients treated at the George Washington University Emergency Department between November 1, 1990 and November 31, 1992. Information regarding the worker, the injury, and the injury circumstances were abstracted from medical records. Information was obtained on 592 injured construction workers from numerous trades. Lacerations were the most commonly treated injuries among these workers, followed by strains and sprains, contusions, and eye injuries. Injuries were most commonly caused by sharp objects (n = 155, 26%), falls (n = 106, 18%), and falling objects (n = 70, 12%). Thirty-five percent of injuries were to the hands, wrists, or fingers. Among the twenty-eight injuries severe enough to require hospital admission, eighteen (64%) were caused by falls. Laborers and Hispanic workers were overrepresented among these severe cases. Emergency Department records were a useful surveillance tool for the initial identification and description of work-related injuries. Although E codes were not that useful for formulating prevention strategies, detailed review of injury circumstances from Emergency Department records was valuable and has helped to establish priorities for prevention activities.

There are few industries as hazardous as construction. Work at elevations, work involving heavy overhead loads, operation of heavy machinery and power tools, confined space work, temperature extremes, and material-handling demands combine to increase the risk of injuries. The temporary and constantly changing nature of both the work site and the work force also contributes to injury risk. Engineering controls on the work site may be absent or inadequate, and personal protective equipment may be cumbersome. According to Bureau of Labor Statistics data for 1990, construction workers lost 146.1 days from work per 100 workers (per 200,000 hours) because of occupational injuries, nearly twice as many days lost as the all-industry average of 78.3. This difference in lost work-time from injuries is explained by the higher frequency of lost-time construction injuries, rather than by their severity.[1] Fatality rates are also much higher in construction than in general industry. The Bureau of Labor Statistics[1] and the National Safety Council[2] both estimate that fatality rates for the construction industry are about 4 times as high as for all industries.

There were approximately 210,000 disabling injuries to construction workers in 1990, and 2,100 work-related deaths, according to National Safety Council estimates.[2] A number of studies have investigated occupational fatalities and their causes among construction workers; far fewer studies have looked at nonfatal work-related injuries. Some studies have found falls to be the most common cause of fatality among construction workers.[3–5] Suruda[4] found that 50% of painter fatalities resulted from a fall from height. In a study of non-

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fatal injuries to carpenters, falls were also the most common cause of injury.[6] Workers' compensation claim data, on the other hand, showed overexertion to be the leading cause of compensable injury to construction workers, causing 24% of claims, whereas falls were responsible for only 14% of claims.[7]

Surveillance data on occupational fatalities generally have come from either death certificates,[8,9] state or federal Occupational Safety and Health Administration accident investigations,[3,4,10] or multiple data sources.[5] Workers' compensation records are a retrospective source of data on nonfatal occupational injuries.[7] Concurrent injury surveillance requires more resources and has been carried out through SENSOR programs[11] and in emergency room[6] and occupational health clinic-based studies.[12]

To learn more about the causes of nonfatal construction worker injuries, and to identify injury cases for further work-site–based investigations or prevention programs, an emergency department-based surveillance program was established. This paper presents results from the first 2 years of data collection.

Methods

Construction workers with work-related injuries or illnesses were identified by reviewing the medical records of all patients treated at the George Washington University Emergency Department between November 1, 1990 and October 31, 1992. Construction workers were defined as those employed in the construction industry, that is, Standard Industrial Classification (SIC) codes 15 to 17.[13] In practice, it was not always easy to identify construction workers from the information contained in the medical record because registration clerks did not explicitly ask patients whether they worked in construction, and employment data collected by the clerks included only the patient's job title and the name and address of the employer. Using this information (job title and employer) in combination, we identified patients who were likely to be construction workers. We occasionally telephoned employers to determine whether the company performed construction work. Patients with construction trade job titles (eg, painters) but who were most likely doing maintenance for fixed-site employers were excluded from this surveillance data base.

All patients with injuries are explicitly asked at registration if they were injured on the job; if so, the chart is coded as a workers' compensation case. Employers are later contacted to verify workers' compensation payment information. Because all work-related injuries are not paid by workers' compensation insurance, however, the entire chart for each construction worker was reviewed to determine whether conditions were work-related. In addition to type of insurance, the information reviewed included notes regarding the presenting complaint, notes made by any treating clinician about how or when the injury occurred, and physician's check in a box labeled "work-related." These sources were not always consistent in indicating work-relatedness. We included the case if (1) the notes clearly described an injury that occurred at work, or (2) it appeared from the notes that the injury was work-related and workers' compensation was noted as the payment source, or (3) it appeared from the notes that the injury was work-related and the physician checked the "work-related" box.

The following data were abstracted from the medical record for each construction worker with a work-related diagnosis: date of visit, medical record number, state and zip code of residence, gender, date of birth, ethnic group (assessed visually by the registration clerk), employer name and city, occupation, up to two diagnoses, and the circumstances of the injury. Occupation was later coded according to Standard Occupational Classification (SOC) codes,[14] and diagnosis codes and E codes were assigned by project staff according to the International Classification of Diseases, 9th Revision (ICD-9).[15]

Results

Between November 1990 and October 1992, 592 construction workers with occupational injuries or illnesses were treated at the George Washington University Emergency Department, an average of 5.7 cases per week. Information on workers' compensation was available for 22 of the 24 months of our study. During that time, 88.4% (482 of 545) of the injured construction workers were registered and verified with employers as workers' compensation cases. During the same 22-month period, the Emergency Department received 82,253 initial patient visits, 7,642 of which were registered and verified as workers' compensation cases. Thus, workers' compensation construction work-

TABLE 1
Demographic Characteristics of 592 Injured Construction Workers, GWU* Emergency Department Surveillance Data Base, 11/1/90--10/31/92

Demographic Characteristic	No.	%†
Gender		
Male	570	96.3
Female	21	3.5
Unknown	1	.2
Ethnicity		
White	291	49.2
Black	155	26.2
Hispanic	106	17.9
Other	6	1.0
Unknown	34	5.7
Age, y		
16–24	98	16.6
25–34	270	45.6
35–44	147	24.8
45–54	55	9.3
55–64	18	3.0
>65	3	.5
Unknown	1	.2
Occupation		
Carpenter	141	23.8
Laborer	101	17.1
Construction worker, NOS‡	64	10.8
Electrician	48	8.1
Supervisor/foreman	31	5.2
Plumber, pipe/steamfitter	26	4.4
Drywall installer, finisher	23	3.9
Iron workers/rodmen	23	3.9
Sheet metal workers	21	3.5
Roofers	18	3.0
Insulators/asbestos workers	17	2.9
Other trades	79	13.3

* GWU, George Washington University.
† Because of rounding, some categories do not total to 100%.
‡ NOS, not otherwise specified.

TABLE 2
Types of Injuries* Treated among 592 Construction Workers, GWU Emergency Department Surveillance Data Base, 11/01/90–10/31/92

Type of Injury Most common diagnoses	No. of Injuries†	No. of Cases‡	%
Laceration		225	38.0
Finger/thumb	86		
Wrist/hand	57		
Face/scalp/head	40		
Sprain/strain/musculoskeletal pain		102	17.9
Back	49		
Upper extremity	17		
Ankle	15		
Neck	11		
Knee	7		
Contusion/abrasion		93	15.7
Eye injuries		73	12.3
Abrasion/superficial	30		
Foreign body in eye	29		
Infection/irritation	8		
Burn	7		
Laceration	6		
Muriatic acid in eye	1		
Fracture		54	9.1
Wrist/hand/fingers	19		
Ankle/foot/toes	10		
Leg	9		
Crush injury		19	3.2
Joint dislocations/derangements		15	2.5
Burns		13	2.2
Head injury/concussion		11	1.9
Toxic effects of exposure		6	1.0
Other		33	5.6

* Data are based on 707 injuries treated among 592 injured workers. Up to two diagnoses are recorded per case.

† Except for the eye injuries category (which lists all diagnoses), only the most common diagnoses in each category are listed as examples.

‡ Number of cases with one or more injuries in this category. For instance, a worker with a finger laceration and a facial laceration would only be listed once in this category total.

er injuries constituted 6.3% (482 of 7,642) of all workers' compensation injuries treated at this large urban emergency department.

The injured workers were predominantly young; 62% were less than 35 years of age and the median age was 31. Of the 558 workers whose ethnicity was noted, 267 (48%) belonged to minority groups, primarily black or Hispanic. Table 1 presents further demographic detail, and also describes the occupations of construction workers in the surveillance data base. The most prevalent occupation was carpenter (24% of cases)—a number of whom were exhibit carpenters involved in constructing convention exhibits. Laborers (17%) and "construction workers," not otherwise specified (11%) were the next most common occupation among injured workers. (We believe that those who identified themselves only as "construction workers" were probably construction laborers, because construction workers with a specialty trade usually identify themselves as such.) The remaining 48% of cases were supervisors or specialty construction trades workers, for instance, electricians (8%), plumbers and pipefitters (4%), and iron workers (4%).

Table 2 describes the types of injuries seen among these construction workers. Lacerations were the most common, occurring among 38% of cases. The most common body locations are listed; more than half of the lacerations were to the finger, thumb, hand, or wrist. Construction workers with sprains, strains and musculoskeletal pain were also seen frequently in the George Washington University Emergency Department. Low back symptoms accounted for 8% of the emergency room visits by construction workers during this 2-year period. Twelve percent of the injured workers were treated for eye injuries; further detail on eye injuries will be given later. Two hundred five workers (35%) had hand, finger, or wrist injuries. This number was obtained by summing injuries to these locations across all diagnosis categories (data not presented).

In Table 3, the injuries are grouped by causal circumstances as classified by E codes. In most cases the cause was acute trauma; there were also some cases caused by chronic trauma, and some caused by chemical or physical exposures. Not unexpectedly, given the preponderance of lacerations in Table 2, the leading causes of construction worker injuries were cutting or piercing objects (n = 155, 26%), such as sheet metal or other metal objects, powered hand tools, or knives and razors. Falls (n = 106, 18%) and being struck by falling objects (n = 70, 12%) were also important causes of injuries in this case series. Almost one-third of the falls were from ladders; falls from scaffolds were also common. Of the 12 workers with burns, 4 (3 roofers and a laborer) were splashed with hot tar; one received third-degree burns. Although this was not a very frequent category, the hazard is very specific and injuries are largely preventable through the use of proper work practices and protective clothing.

Summarized surveillance data, as they are presented in Tables 2 and 3, do not really bring us closer to understanding the preventable causes of occupational injuries. To understand injury circumstances in a manner most relevant for prevention, it is necessary to go back to the most detailed description of how each injury occurred, rather than relying on E code or diagnostic groupings. As an example of this more detailed evaluation, Table 4 presents information on circumstances and occupations for the 73 construction worker eye injuries that were recorded by this surveillance system. Eighteen eye injuries occurred while working with machinery or tools, most commonly drilling or welding. For three of these machinery-related eye injuries, the medical chart

TABLE 3
Circumstances Related to 592 Construction Worker Injuries, with E Codes, GWU Emergency Department Surveillance Data Base, 11/01/90–10/31/92

E Code	Circumstances*		No.	%
E920.1–E920.9	Cutting or piercing object		155	25.8
	Sheet metal/metal	44		
	Powered hand tools	22		
	Knife/razor	23*		
E880–E888	Fall		106	17.9
	From ladder	34		
	From scaffold	25		
	Trip on same level	13		
E916	Falling object		70	11.8
	Pipe/tube	11		
	Heavy equipment	10		
	Beam	8		
E914	Foreign object enters eye		52	9.8
E927	Overexertion/strenuous movements		48	8.1
	Lifting	32		
E917.9	Struck against or struck by object		47	7.8
	Board/wood	8		
	Piece of metal	6		
	Pole/pipe	5		
E919.1–E919.9	Machinery		42	6.4
	Woodworking machinery	15		
	Lifting machines	10		
E918	Caught in or between two objects		27	4.6
	Involving dolly/cart	4		
	Involving pipe	4		
E924.0–E924.1	Burns		12	2.3
E898.1	Hot tar	4		
	Torch/flames	3		
	Other		33	5.6

* Only the most common injury circumstances in each category are listed as examples.

indicated that the worker was wearing safety glasses; for one case, the use of protective goggles was noted. It can be seen from the table that the remainder of eye injuries were caused by a variety of circumstances, and in 24 cases the worker's activity at the time of injury was not specified in the medical chart.

It is interesting to look at the worker's occupation in relation to the task being done at the time that eye injuries occurred. Some tasks, such as welding, tend to be done by specific construction trades. On the other hand, powered drills and saws are used by many trades while performing diverse tasks.

The most serious injuries in this case series included fractures, crushes, lacerations with nerve or tendon involvement, head injuries, and toxic exposures. Among the workers treated for toxic exposures, there was a laborer who was overcome by methylene chloride fumes while working in a room with paint stripper, and two electricians who suffered carbon monoxide poisoning from working near gas-powered forklifts in an enclosed freezer. The methylene chloride poisoning case and one of the carbon monoxide cases received hyperbaric oxygen treatment. Other serious cases resulted from falls. In two separate incidents, an ironworker and a laborer fell 50 to 60 feet from the same elevated highway. Both sustained multiple fractures and required long hospitalizations. In another case, a head injury was sustained by an electrician who fell 8 feet from a ladder after having his hand caught between a heavy mounted drill and a ladder rung for 45 minutes. Although falls from ladders and scaffolds were most common, one carpenter experienced an elbow fracture after falling from stilts. Another potentially serious incident was a closed head injury sustained by a laborer after he was hit in the back of the head by a cable from a crane. There were four injuries involving amputation or partial amputation of the hand or fingers. Three of these injuries were caused by large objects (a steel beam, a lead pipe, and a rock) falling on the finger or hand; the fourth, a partial amputation of the left hand, was caused by a circular saw.

Twenty-eight of the 592 injured construction workers (4.7%) were admitted to the hospital. This compares with 131 admissions (1.7%) from among all 7642 injuries paid for by workers' compensation insurance during the 22 months for which we had data. Table 5 describes the construction worker injuries resulting in hospital admission; frequently these injuries were multiple and quite severe. Eighteen of 28 (64%) resulted from falls. Thirty-nine percent of those patients admitted were Hispanic, 39% were white, and 21% were black. Seventeen workers (61%) were either construction laborers or stated their occupation as construction worker.

Discussion

This surveillance project provides a source of data on nonfatal construction worker injuries requiring medical care in an emergency department. Because the case series is not based on population we do not have denominator data to calculate injury rates either for construction workers as a whole or for specific trades. Our data show that construction worker injuries billed to workers' compensation constituted 6.3% of all workers' compensation injuries treated at this large urban emergency department. In 1980, the construction industry accounted for 5.1% of employment in the Washington DC metropolitan area; 1990 projections were that construction work would constitute 4.5% of area employment.[16] Thus, construction workers were slightly overrepresented in this case series compared with their proportion of the local labor force. Because George Washington University is only one of several large hospital emergency departments in the Washington area, and because construction patterns and hospital referral patterns differ widely throughout the area, these demographic data may not be represent-

TABLE 4
Injury Circumstances and Occupations of 73 Construction Workers with Eye Injuries,* GWU Emergency Department Surveillance Data Base, 11/01/90–10/31/92

No.		Task/Circumstances	Occupation
18		Working with machinery or tools	
	6	Drilling and grinding steel	Iron worker
		Drilling metal with protective lenses	Contractor†
		Drilling metal	Carpenter
		Drilling concrete	Construction worker†
		Drill handle hit face	Carpenter
		Overhead drilling	Iron worker
	4	Welding	Boilermaker
		Welding wearing safety glasses	Foreman
		Welding wearing safety glasses/ respirator	Steamfitter
		Soldering	Steamfitter
	8	Sawing wood	Carpenter
		Cutting marlite (plastic)	Construction worker
		Dust kicked up from unspecified machine	Sheet metal mechanic
		Shaving iron	Construction worker
		Chipping concrete with protective goggles	Carpenter
		Using nail driver	Carpenter
		Hammering old cement	Sheet metal worker
		Hammering	Construction worker
13		Other work tasks	
		Loading trash	Laborer
		Cleaning bucket of concrete	Iron wkr/Bridge mechanic
		Threading air suspended bolt	Electrician
		Working with sheet metal	Sheet metal apprentice
		Working with bricks	Laborer
		Working on styrofoam ceiling	Construction worker
		Working on ceiling	Electrician
		Hanging drywall	Dry wall applicator
		Working with drywall, wearing glasses	Carpenter
		Putting cement on wall	Plasterer
		Removing asbestos; placing protective plastic	Asbestos controller
		Removing asbestos	Asbestos remover
		Standing over air conditioner	Electrician
8		Struck by	
		Hit by shovel	Roofer
		Crane hook	Carpenter
		Poke with wire (3)	Electrician (2)/Carpenter
		Shattered glass	Carpenter
		Screw	Carpenter
		Exploding light bulb	Carpenter
6		Chemical exposure	
		Splashed in eye with liquid polyester resin	Construction worker
		Chemical primer in eye	Steamfitter
		Non-specified chemical sprayed into eye	Insulation installer
		Glycerin exposure from exploding sprinkler head	Pipefitter
		Splashed with turpentine	Laborer
		Acid spill	Laborer
2		Walking by	
		Walked into mortar dust cloud	Carpenter
		Walked near wood cutting	Plumber
2		Electrical current	
		Flash explosion from 480-volt wire	Electrician
		Exposed to sparks from 220-volt line	Electrician

Continued on next page

ative and should be interpreted cautiously.

We identified construction workers with work-related injuries from data in the medical chart; there may be a small amount of misclassification regarding both construction worker status and work-relatedness of injuries. Construction worker status is most unclear when people with construction trade occupations work in nonconstruction settings. Some of these people may have been mistakenly included in the case series, and some "real" construction industry workers may have been mistakenly excluded. We nonetheless believe that this type of misclassification was relatively infrequent. Misclassification of work-relatedness of injuries also may have occurred in identifying this case series because we used multiple sources of information in the medical record to designate an injury as work-related, and because these sources were not always in agreement. We excluded a small proportion of potential cases for which work-relatedness was not clear; our case series may therefore have undercounted these cases.

Except for data that come from workers' compensation records, we are not aware of any other study that has collected data on nonfatal injuries involving construction workers of all trades.[7] Lacerations were the most commonly treated injuries in this case series, followed by strains and sprains, contusions, and eye injuries. Injuries were most commonly caused by sharp objects, falls, and falling objects. Thirty-five percent of injuries were to the hands, wrists, or fingers.

A retrospective questionnaire survey of 3700 injured construction laborers identified through workers' compensation records found sprains and strains to be most common (38%), followed by lacerations (25%), contusions (20%), and fractures (19%).[17] As in our study, patients could report more than one type of injury. Twenty-nine percent of injured workers reported manual lifting or carrying activities at the time of their injuries, and 15% reported power tool use, whereas 32% were using unpowered tools. Nine percent of injuries were to the eye, which is similar to our 13% proportion,

TABLE 4—Continued

No.	Task/Circumstances	Occupation
24	Fragment blew/flew/fell into eye, activity unspecified	Carpenter (6) Laborer (4) Construction worker (3) Welder (2) Steamfitter Architect Contractor Demolition worker Elevator constructor Labor/Supervisor Plasterer Sheetmetal technician Yardman

* 81 eye injury diagnoses (see Table 2) were recorded among these 73 cases.
† Trade not further specified for "Contractors" and "Construction workers."

TABLE 5
Information on 28 Injured Construction Workers Admitted to GWU Hospital, Emergency Department Surveillance Data Base, 11/1/90–10/31/92

Occupation	Ethnicity,* Age	Injuries	Circumstances
Laborers/construction workers NOS†	H, 22	Head injury with loss of consciousness	Fell 15 ft from scaffold and was also struck by scaffolding bar
	B, 32	Rib contusion; ankle sprain	Fell 20 ft from one scaffold onto another
	B, 40	Forehead laceration, subsequent back pain	Fell 20 ft from scaffold onto head
	B, 39	Lower leg and foot fxs‡	Fell 20 ft from scaffold onto feet
	H, 35	Scalp laceration	Tripped and fell 30 ft from scaffold
	H, 35	Brain injuries, clavicle fx	Fell 10–15 ft from scaffold
	H, 27	Ankle fx and dislocation	Fell from scaffold
	H, 42	Rib and pelvic fxs, with renal contusion	Fell off ladder 15 ft through open stairwell
	W, 43	Low back pain	Fell 12 ft from roof when attempting to climb down ladder
	B, 56	Multiple fxs, liver and kidney lacerations and respiratory complications	Fell 50 ft from elevated highway construction site
	W,§ 51	Closed head injury, multiple fxs and respiratory complications	Fell 40 ft circumstances not described
	H, 52	Multiple leg fxs	Struck by 2000 lb beam
	W, 36	Forehead contusion and hematuria	Struck by 1200 lb beam
	H, 28	Pain in left side	Struck by beam, fell 5 ft
	W, 27	Multiple facial fxs and lacerations; ankle fx	Struck by 300 lbs of wood while unloading it from truck
	H, 21	Forearm and wrist fxs	Caught arm in cement mixer

Continued on next page

whereas wrist, hand, or finger injuries constituted 22% of the total, substantially less than the 35% we observed. These injuries were identified through workers' compensation records, so they were not necessarily acute trauma cases treated in an emergency room. In particular, injuries related to overexertion—the causal factor in 22% of these 3700 workers' compensation cases—would often be treated by a primary care provider.

Niskanen and Lauttalammi[18] focused on factors influencing 442 material-handling injuries at one large construction company. They found that material-handling injuries most often occurred during the building of frame structures, and further evaluated the tasks related to injury, by type of injury. Back injuries accounted for 28% of all material-handling injuries.

A study using methods similar to ours looked at woodworking injuries among carpenters treated in the emergency room or hospital of a Vermont medical center.[6] Although carpenters often work with materials other than wood, nonwoodworking injuries were excluded. (*Any* construction work-related injuries were included in our study.) One-quarter of the injured workers fell from ladders, ramps, or scaffolds. Twenty-three percent of the injuries were related to power tool use, frequently circular or skill saws, while in 14% of cases, the power tool was the actual agent of injury. Fifteen percent of cases were eye injuries, usually from flying sawdust. In contrast, our carpenter eye injuries were related to more diverse exposures (Table 4), which can be explained by the fact that our study focused beyond woodworking activities. Follow-up interviews were conducted to determine duration of disability: 43% suffered no disability, whereas 20% were disabled for a month or longer. Seven percent of the injured carpenters were hospitalized.

We did not collect information on lost work time or disability resulting from injuries among the cases in this series. Twenty-eight (4.7%) of the workers in this case series were admitted to the hospital. Among those cases, the initial hospital stay ranged from 1 day to 55 days, and averaged 13 days. For those cases for which cost

TABLE 5—Continued

Occupation	Ethnicity,* Age	Injuries	Circumstances
	B, 48	Cellulitis as late effect of open foot wound	Piece of metal went through sole of work boot
Electricians	W, 28	Carbon monoxide poisoning	Working in enclosed freezer where gas powered forklift was used
	H, 26	Electric shock and forehead contusion	Working on 270-volt fixture, shocked, fell from stepladder
	W, 26	Subdural occipital hematoma	Fell 8 ft from ladder after catching hand between mounted drill and ladder rung for 45 minutes
Carpenters	W, 54	Compression fx of thoracic spine	Fell 12 ft from scaffold landing on feet
	B, 54	Dislocation of foot	Twisted leg climbing down scaffold
Ironworker	W, 24	Spinal fx; respiratory complications	Fell 60 ft from elevated highway construction site
Painter	H, 37	Multiple spinal, pelvic, leg and foot fxs	Fell 50–60 ft from scaffold landing on construction debris
Rodman	W, 40	Closed head injury, scalp laceration	Fell 30 ft, circumstances not described
Sheetmetal worker	W, 33	Open ankle fx and dislocation	Fell from ladder, caught foot in rung
Steamfitter	W, 28	Corneal burn (chemical) and iritis	PVC primer in eye
Stone mason	H, 28	Lumbar fxs, closed head injury	Fell 7 stories from scaffold

* H, Hispanic; B, Black; W, white.

† NOS, not otherwise specified. Construction workers, NOS, were grouped with laborers for this table and related analyses.

‡ Fx, fracture.

§ Russian speaking.

data were available, the hospitalization cost ranged from $1,502 to $147,384; the average cost per hospitalized case was $24,700.

A large majority of these severe (hospitalized) injuries—18 of 28 (64%)—resulted from falls. More than half of these falls were from scaffolds. Several studies have found falls to be the most common cause of construction worker fatalities, including 30% of fatal construction worker injuries in Washington State,[3] 47% of work-related fatalities among New Jersey construction workers,[5] and 50% of painter fatalities.[4] In contrast to the results of Washington State and New Jersey fatality studies, which observed many injuries due to motor vehicles and trench cave-ins, we did not observe *any* injuries due to either of these causes.

Laborers and Hispanic workers were overrepresented among the 28 cases severe enough to be admitted to the hospital. Among those injured workers admitted to the hospital, 17 (61%) were either construction laborers or stated their occupation as construction worker and were probably laborers, compared with 28% among all 592 injuries. Thirty-nine percent of those patients admitted were Hispanic, compared with 18% among all 592 cases. If this comparison of Hispanic status among severe injuries and all injuries is stratified by laborers versus other occupations, the results are as follows: 47% (8 of 17) of severe injuries among laborers were Hispanic versus 40% (66 of 165) Hispanic among all injuries to laborers, and 27% (3 of 11) of severe injuries among other occupations were Hispanic, versus 9% (40 of 427) Hispanic among all injuries in other occupations. Thus, although the number of severely injured workers is small, it appears that occupation (laborer) and Hispanic ethnicity may be independent factors associated with more severe injuries.

Job tasks and associated injury risks clearly vary by trade, and laborers typically perform some of the heaviest and least desirable jobs in the construction industry. More research is needed on job-specific injury risks within the construction industry. Even within the laborer group, there may be some differences by ethnicity in the types of jobs assigned and other employer practices. In this study, more than 60% of all injured Hispanics had been working as laborers or construction workers. We should also note here that one of the most severely injured workers in our case series was a laborer who spoke only Russian. Besides language barriers to knowledge and communication, differences between ethnic groups in work practices, union representation, training, and risk-taking may also account for differences in injury risk. In a study of New Jersey construction industry fatalities, Sorock et al[5] estimated that those of Hispanic origin had higher death rates than either US-born blacks or whites. A study of less severe injuries in California also showed Hispanics to have higher rates of work-related injuries than non-Hispanic whites.[19] More research is needed to identify possible causes and prevention measures for the suggested associations between ethnicity and injury severity.

Of the 592 construction worker injuries identified by this surveillance program, 88% were registered as and verified as workers' compensation insurance cases. Sorock et al[20] found, in a telephone survey following hospitalization for injuries, that 81% of 134 injuries reported by the patient as occurring at work had been paid by workers' compensation insurance. These data indicate that the number of workers' compensation cases is an underestimate of the total number of work-related injuries. Although we did not obtain payment information data for injuries not paid by workers compensation, we expect that some of these injuries occurred among self-employed workers not covered by workers' compensation, and that some were paid through other insurance. (In the study by Sorock et al,[20]

TABLE 6
E Coded Classification of 73 Construction Worker Eye Injuries, GWU Emergency Department Surveillance Data Base, 11/01/90–10/31/92

E Code	No.	E Code Description
914	52	Foreign object accidentally entering eye and adnexa (including 2 late effects)
916	3	Struck accidentally by falling object
		Struck against or struck accidentally by objects or persons
917.9	1	Other
		Accidents caused by machinery
919.2	1	Lifting machines and appliances
919.8	4	Other specified machinery
919.9	1	Unspecified machinery
		Accidents caused by cutting and piercing objects
920.1	2	Other powered hand tools
920.4	1	Other hand tools and implements
920.8	4	Other specified cutting and piercing instruments or objects
		Accidents caused by hot substances or objects, caustic or corrosive materials, and steam
924.1	2	Caustic and corrosive substances
		Accidents caused by electric current
925.2	1	Industrial wiring, appliances and electrical machinery
	1	Unspecified electrical current

only 2% of injuries paid by workers' compensation were later described by the injured person as nonwork-related.)

This case-series investigation provides numerator data only on injured workers; comparison data on demographic characteristics and work tasks performed by the entire construction worker population-at-risk are not available. As such, risk factors cannot be statistically assessed. Descriptions of the immediate circumstances of injuries do, however, provide a means of identifying hazards and hazardous situations.

An evaluation of eye injury circumstances identified clearly hazardous tasks. These include welding, drilling, and using other power tools and machines. Safety glasses or goggles with front, *bottom, and side* protection should be used routinely for these tasks. Aside from welding and power tool use, it is difficult to link eye injury hazards to a set of restricted tasks. A number of eye injuries occurred while working on ceilings and walls—situations where a worker might be looking up and dust or splashes could fall into the eyes. In general, construction sites are dusty and construction workers handle many different solid and liquid materials such as paint, drywall, cement, and insulation. The use of eye protection during a greater variety of construction activities would prevent many eye injuries.

There is little information available on the use of eye protection on construction sites during the performance of risky tasks. A few of our medical records noted that workers were wearing safety glasses or goggles when eye injuries occurred; we don't have any information on eye protection when the medical record did not note it. More importantly, we don't know the prevalence of eye protection use among workers on the construction sites where these injuries occurred, and therefore don't know how many eye injuries were prevented through use of eye protection. In a small pilot study in which we interviewed 31 construction workers (various injuries) while they were still in the emergency department, 19% reported wearing eye protection at the time of the injury. In a large questionnaire study of construction laborers with various injuries, 18% reported wearing safety goggles, glasses, or other eye protection at the time they were injured.[17] Neither of these surveys addresses the question of eye protection use during specific risky tasks.

E codes are useful indicators of basic injury mechanisms, and in general are useful for research and surveillance purposes. For instance, E codes on a hospital discharge data base may identify injury cases due to certain causes for further study. In this study, E codes, while helpful for summarizing data, were not very helpful in the analysis of injury circumstances or in devising strategies for prevention. Because E codes lack detail regarding tasks and tools that pose hazards to construction workers, we found it necessary to go back to the most detailed descriptions available and look at injury causes on a case-by-case basis.

For instance, Table 4 presented data on eye injury circumstances that were far more detailed than E codes would have provided. A tabulation of these injuries by E code alone is shown in Table 6. Fifty-three (73%) of these injuries fall under E914 (foreign object entering eye). The other injuries are classifiable to a number of other E codes; it is interesting to note that *none* of these E codes identifies the *specific* agent of the injury. Sorock and coauthors[20] have recently commented on the lack of detail on occupational injury circumstances provided by E codes and have recommended expanding E codes to include more detailed categories, including more types of machinery.

The medical record, designed to obtain information relevant to the treatment of injuries and illnesses, often lacks information on injury circumstances. Information present in the medical record focuses on immediate causes of injuries, and is often inadequate to understand underlying conditions and causes. Most medical records included a description of the immediate injury circumstances but did not note the activity of the worker just before the injury. These, for instance, are typical examples: "fell 6 feet from ladder onto concrete surface," "100-lb crate fell on left side of face," or "cut by razor knife." This lack of de-

tail is a limitation of using medical records to obtain information on injury circumstances or on occupational exposures in general. There were occasionally cases with more informative descriptions, for instance: "repairing forks of forklift, whole unit fell on his foot," "2×4 flew off table saw while cutting and struck hand," "lacerated while cutting drywall with metal knife." However, if further detail is desired, it is generally necessary to survey injured workers directly. In our surveillance program, with only about one construction injury treated per day, telephone interviews following discharge, rather than personal interviews before discharge, present the most feasible follow-up option.

Emergency Department records are a valuable source for the initial identification and description of work-related injuries, and can help to establish priorities for prevention activities. Our current surveillance project involves abstracting information from the emergency department records, and then telephoning construction workers within several days of their injury to collect more detailed information on injury circumstances, relevant background data such as work practices and worker training, and workers' ideas about possible preventive measures. Plans for prevention projects are currently focused on injuries among electricians, exhibit carpenters, and hispanic construction workers. We hope to be able to report in the future on the successes of prevention efforts that have arisen from this surveillance project.

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Power

"You know you're out of power when your limousine is yellow and your driver speaks Farsi."

Former Secretary of State James Baker, at a recent Washington dinner.

From "Overheard." *Newsweek,* 1993;121:10, p 17