Temporal Factors and the Prevalence of Transient Exposures at the Time of an Occupational Traumatic Hand Injury

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Temporal factors and the prevalence of exposure to transient risk factors for occupational traumatic hand injury were analyzed among 1166 subjects participating in a case-crossover study. Temporal factors included time of injury and elapsed time to injury since the start of the work shift. Transient exposures included work equipment, work practice, and worker-related factors. The highest frequency of injury was observed from 08:00 AM to 12:00 PM (54.6%), with a peak from 10:00 to 11:00 AM (14.9%). The median time into the work shift for injury was 3.5 hours. Subjects injured 2 to 3 hours into their work shift most often reported using a machine, tool, or work material that performed differently than usual (23.9%). These results suggest that acute hand injuries occur earlier in the workday and safety programs should place increased vigilance on these times. (J Occup Environ Med. *2003;45: 832–840*)

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Temporal factors, such as the time of day and time into the work shift, have been associated with workplace injuries and accidents.[1–6] For example, occupational acute injuries have been reported to occur more frequently just before lunchtime, with the fewest occurring in the evening,[1] and at a higher frequency during earlier rather than later shifts (morning versus afternoon or evening).[2–4] The distribution of time into the work shift of injuries and accidents is also fairly well characterized and is most frequently reported to peak in the first half of the workday[2,5] with a second peak occurring near the end of the workday.[3,6]

It is unclear whether specific factors influence injury frequency and risk at different times of the workday. Few studies have examined the temporal distribution of transient occupational exposures and how they relate to injury; however, it has been suggested that changes in work processing (from manual set-up to automatic) may contribute to the increased frequency of injuries early into the work shift.[2] Workplace exposures may be present over long periods of time (ie, months) or shorter periods of time (ie, minutes or hours). Transient exposures can be worker-related (eg, rushing) or features of work equipment (eg, malfunctioning machines) or work practices (eg, performing an unusual task).[7] A better understanding of the temporal distribution of transient exposures during the workday may contribute to more precise time-

dependent safety interventions to reduce workplace injuries.

To describe the temporal distribution of transient occupational exposures, we conducted an analysis of 1166 workers from a broad range of occupations who experienced an acute traumatic hand injury. Subjects were enrolled in a case-crossover study examining the association of transient work equipment, work practice, and worker-related exposures with hand injury. Time of day, time into the work shift, and prevalence of exposure at the time of the injury were recorded and compared for multiple transient exposures.

Patients and Methods

Study Population

The study methods have been published in detail elsewhere[7] and are briefly summarized here. A multicenter, interview-based, case-crossover study was designed to assess risk factors for acute traumatic occupational hand injuries. Subjects were recruited from September 1997 to November 2000. During the last 9 months of the study, enrollment was restricted to women to increase their numbers. Subjects were recruited in New England from 16 freestanding clinics that were part of two occupational health clinic networks, three manufacturing companies, two hospital-based and one rehabilitation-based occupational health care centers, and a hand surgical practice. The study was approved by the Harvard School of Public Health Human subjects Committee and the Liberty Mutual Research Center Institutional Review Committee.

Study Sample

Enrollment eligibility was determined at the initial visit by the treating clinician at the participating health clinic. A subject was eligible if the injury occurred at work within 36 hours of presentation and was to the hand, finger, or wrist. The treating clinician initially determined whether the injury was work-related, which was subsequently verified during the subject interview. The type (or nature) of injury had to be a laceration, crush, puncture, avulsion, amputation, fracture, or contusion. Subjects with hand injuries from a needle-stick, bite, repetitive motion disorder, cumulative trauma, or a sprain or a strain injury from a fall were not eligible.

A total of 1616 subjects agreed to participate at the clinic sites. Of this total, 94 were not eligible for interview. Of the remaining 1522 subjects eligible for a telephone interview, 1179 (77.5%) completed the interview using a structured questionnaire and are included in the analysis. If a subject did not consent to participate in the study, no phone interview was conducted and no further information was collected. Thirteen additional interviewed subjects were excluded from further data analysis: four were burn injuries, two were sprain injuries, two had a previous injury, four had poor quality of responses during the interview, and one had an injury caused by violent behavior. Therefore, the final total for evaluation was 1166 subjects.

Data Collection

The signed informed consent form, along with the case information form containing the name, age, gender, the date and time of the injury, and specifics related to the nature of the injury were faxed to the data coordinating center. If possible, a trained interviewer telephoned the subject within 48 hours of the injury and reviewed the information listed on the case information form. Next, the interviewer administered the structured Hand Injury Study questionnaire. The total interview lasted 21 minutes on average, and once completed, the subject was mailed a $25.00 payment. The questionnaire was designed to elicit detailed exposure information for 90 minutes preceding the onset of the hand injury and during the previous month. Other variables collected were age, gender, ethnicity, work shift start and end times, break times, occupation, company size, safety training, job experience, and control over job pace. The *1990 Dictionary of Occupational Titles*[8] was used to code occupations using both job title and the three most common job tasks reported by the subject.

Temporal Factors

For the day of the injury, the start time of each worker shift, the planned duration of the shift, and the time of the injury were collected from each worker. Work shift start time and time of injury were available for 1163 subjects. For analyses of the time-into-the-work shift, we focused on a standard 8-hour shift and included only workers scheduled to work at least 8 hours and who were injured within the first 8 hours of their work shift (n = 981, 84.1% of injured workers). These criteria were used to prevent bias by including workers who were not at risk of injury throughout the entire period. Elapsed time into the work shift of injury (hours and minutes) was calculated for each subject by subtracting the work shift starting time from the time of the injury.

We collected data on worker exposure to six hypothesized transient risk factors and their timing during the 90 minutes before the injury. Subjects who were exposed at the time of the injury (ie, by matching injury and exposures times) were considered exposed in the analysis. The prevalence of each exposure at the time of injury was tabulated for each hour into the work shift. We collected data on transient risk factors in three domains: work equipment factors, including using a machine, tool, or work material that performed differently from usual; work practice factors, including performing an unusual task and doing a task using an unusual work method; and worker-related factors, including being distracted or rushed, and feeling ill.

The test-retest reliability for exposure reported at the time of the injury

TABLE 1
Characteristics of Hand Injury Study Subjects from Occupational Health Clinics, New England (1997–2000)

	Male (*n* = 891)		Female (*n* = 275)		Total (*n* = 1166)	
Characteristic	***n***	**(%)**	***n***	**(%)**	***n***	**(%)**
Age (years)*						
<25	140	(15.9)	43	(15.9)	183	(15.8)
25–34	284	(32.2)	70	(25.8)	354	(30.6)
35–44	263	(29.8)	69	(25.5)	334	(28.9)
45–54	134	(15.2)	62	(22.9)	195	(16.9)
55–64	51	(5.8)	24	(8.9)	75	(6.5)
65+	11	(1.2)	3	(1.1)	14	(1.2)
Mean ± SEM	36.7 ± 0.4		38.7 ± 0.7		37.2 ± 0.3	
Race/ethnicity†						
White/non-Hispanic	537	(78.1)	184	(75.1)	722	(77.3)
Hispanic	81	(11.8)	32	(13.1)	113	(12.1)
Black/non-Hispanic	39	(5.7)	20	(8.2)	59	(6.3)
Other	31	(3.4)	9	(3.2)	40	(4.3)
Type of injury‡						
Laceration	691	(64.1)	186	(57.6)	877	(62.6)
Crush	135	(12.5)	48	(14.9)	183	(13.1)
Avulsion	79	(7.3)	33	(10.2)	112	(8.0)
Puncture	64	(5.9)	22	(6.8)	86	(6.1)
Fracture	55	(5.1)	12	(3.7)	67	(4.8)
Contusion	38	(3.5)	20	(6.2)	58	(4.1)
Amputation	14	(1.3)	2	(0.6)	16	(1.1)
Dislocation	2	(0.2)	0	(0.0)	2	(0.1)
Total	1078	(100.0)	323	(100.0)	1401	(100.0)
Occupational category						
Machine trades	323	(36.3)	60	(21.8)	383	(32.8)
Service	101	(11.3)	73	(26.5)	174	(14.9)
Construction	163	(18.3)	9	(3.3)	172	(14.8)
Packaging & material handling	81	(9.1)	27	(9.8)	108	(9.3)
Benchwork	68	(7.6)	35	(12.7)	103	(8.8)
Prof. Tech/Managerial	48	(5.4)	37	(13.5)	85	(7.3)
Clerical & Sales	49	(5.5)	21	(7.6)	70	(6.0)
Miscellaneous	58	(6.5)	13	(4.7)	71	(6.1)
Job Experience						
Months ± SEM	81.6 ± 3.2		66.8 ± 5.2		77.7 ± 2.7	

Note: Percentages are column percentages.
* Age was missing for 11 subjects (7 men and 4 women).
† Race/ethnicity was only collected in the final 2 years of the study; therefore, column totals differ.
‡ Subjects may have more than one type of injury.

was evaluated in 29 subjects up to four days following the initial interview.[9] Agreement of reported exposure at the time of the injury ranged from substantial to perfect agreement (kappa, 0.65 to 1.0). For reports of rushing and doing a task using an unusual work method, the kappa statistic ranged from 0.84 to 0.92, suggesting almost perfect agreement, whereas for the use of equipment or work materials that performed differently than usual, there was moderate agreement (kappa = 0.65). Exposure prevalence was low for the other factors.

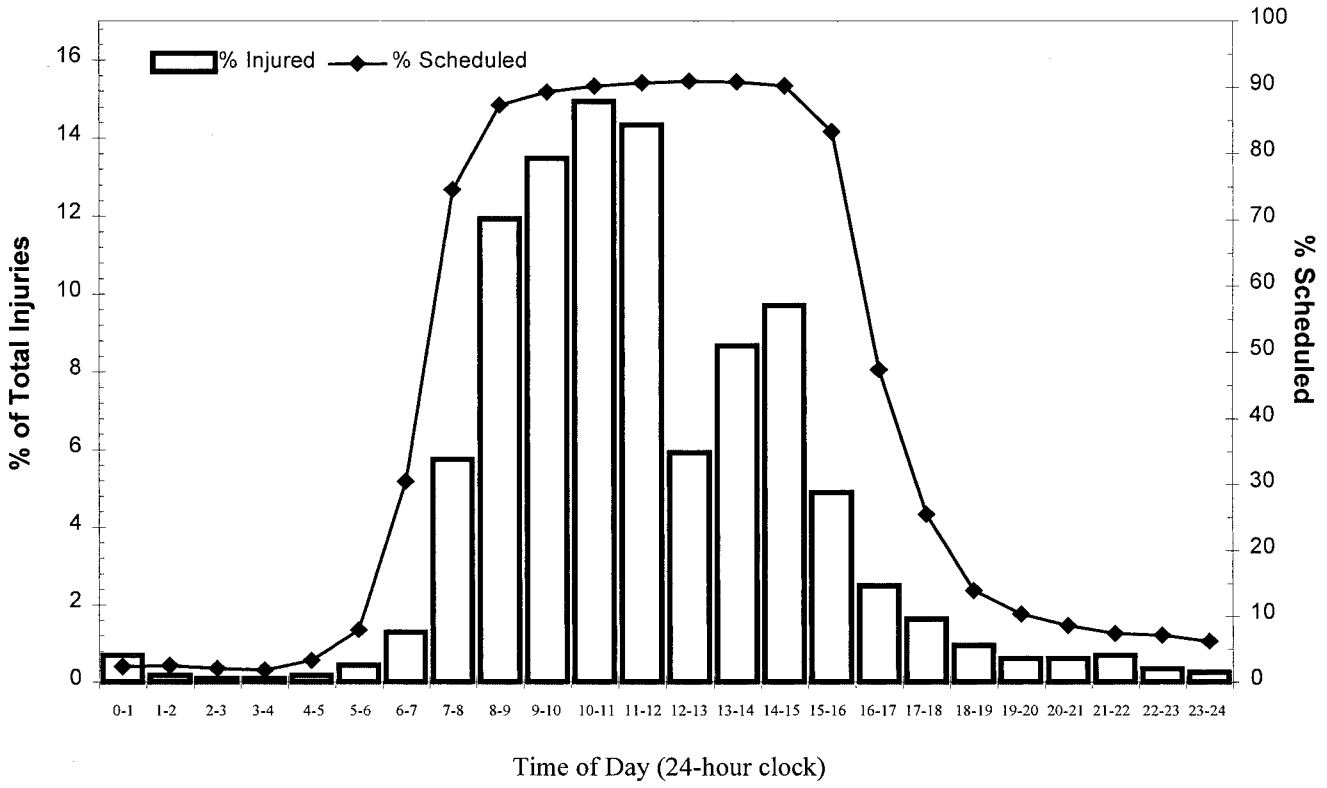
Data Analysis

We used univariate data analysis methods to describe the demographics, injury, and occupational characteristics of the study subjects and stratified all results by gender. We used standard methods to estimate the mean, standard error of the mean (SEM), and 95% confidence intervals for continuous variables and present frequencies and percentiles for categorical variables.

Results

Subject Characteristics

Seventy-six percent of the 1166 study subjects were men. The mean (± SEM) age of the subjects was 37 (± 0.3) years (Table 1). On average, women were slightly older than men. The majority of subjects where white, non-Hispanic (77.3%), followed by Hispanic (12.1%), and



Note: Time of day of injury hourly categories begin with 0000-0100 and end with 2300-2400.

Fig. 1. Percent of subjects injured and scheduled to work by time of day (24-hour clock).

Black, non-Hispanic (6.3%). The type, location, and severity of the injuries have been published in detail elsewhere[10] and are summarized here. Most hand injuries were lacerations (62.6%), followed by crushes (13.1%), avulsions (8.0%), punctures (6.1%), fractures (4.8%), and contusions (4.1%). A small percentage of subjects (1.1%) had a partial finger amputation. Men experienced more lacerations, fractures, and amputations than women, whereas women had more crush injuries and avulsions. Injuries were mostly minor in severity. Lacerations averaged 2.0 ($\pm$ 0.04) centimeters in length and required 4.5 ($\pm$ 0.1) sutures.

Employment was distributed among machine trades (32.8%), service workers (14.9%), construction (14.8%), packaging and materials handling (9.3%), and benchwork (8.8%). The most frequent occupation among men was machine trades (36.3%) and construction (18.3%), whereas for women it was service work (26.5%) and machine trades (21.8%). For men, the median length of job experience was 81.6 months, whereas for women it was 66.8 months.

Temporal Factors

The percent of hand injuries by each hour of the day and the percent of study subjects scheduled to work during each hour are graphically presented in Fig. 1. The largest percentage (54.6%) of hand injuries occurred in the 4-hour morning period from 08:00 to 12:00. The frequency of injuries peaked during 10:00 to 11:00 (14.9%) and decreased during the traditional lunch hour (5.9%). A second peak was observed from 14:00 to 15:00, during which 9.7% of all hand injuries occurred. The percent of hand injuries in this study is not standardized to the number of workers (or person-hours). It is apparent, however, that the majority of study subjects (>50%) were scheduled to work during the daytime hours (07:00 to 14:00) and few were scheduled to work in the evening or early morning hours.

Figure 2 presents the distribution of hand injuries by the time into work shift (hours). Approximately 11.4% of all injuries occurred within the first 60 minutes of the workday. After the first hour, 16% of injuries occurred within each of the next three hourly periods. The percentage of hand injuries was greatest from the beginning of the work shift up until the end of the fourth hour (59.9%). During the fifth hour of work, the period in which there is typically a lunch break, 12.8% of all injuries occurred. After the fifth hour, a relatively constant rate of injuries was noted in each of the next three-hour periods (8.5–10%). Overall, and equally for men and women,

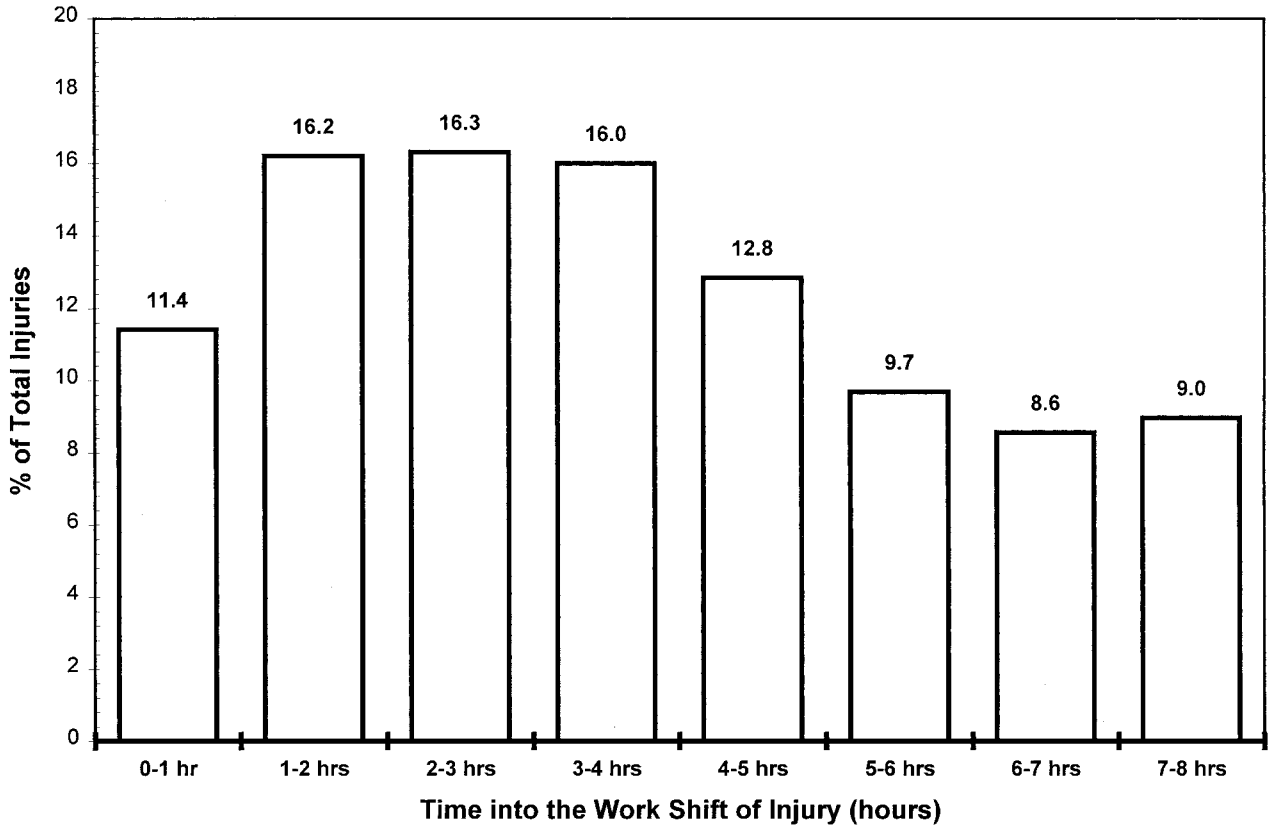


Fig. 2. Distribution of time into the work shift of hand injury (hours).

the median length of time to injury was 3.5 hours (Table 2), which is 30 minutes earlier than the expected median time based upon an 8 hour shift.

With respect to the day of the week of injury, the mean (95% CI) time to injury was latest on weekend days, 4.0 (3.2–5.7). On weekdays, when the majority of hand injuries occurred in this study, there were no significant differences across days and injuries occurred latest on Monday and Friday (median of 3.7 and 3.8, respectively).

Among occupational categories, there were no significant differences in time into the work shift of injury. Most subjects worked in machine trades or bench work and their median time to injury was 3.5 hours. The earliest time into the work shift of injury was observed for those subjects in clerical and sales occupations (median of 2.9 hours) although the size of this group was small (n = 50). There was no statistically significant difference in the time-into-the-work shift of injury by number of years of job experience ($<$ 1, 1 to 3, and $>$3 years) or between those subjects who were self-paced versus non-self paced (ie, machine, quota-time, or incentive based). Injuries occurred slightly earlier for those who where not self paced (median of 3.2 versus 3.5), however most workers (68%) in this study were self-paced.

The prevalence of exposure at the time of the injury reported for each of the six potential transient risk factors (from the three domains) is cross classified by time into the work shift of each hand injury in Table 3 (n = 981). The percentage of subjects reporting any one of the six exposures was greatest for those with hand injuries occurring 2 to 3 hours into their work shift (60.6% or 97/160 subjects).

For exposures reported in the work equipment and work practice domains, 15% of all subjects reported using a machine, tool, or work material that performed differently from usual at the time of their hand injury. The period with the highest prevalence of this exposure was 2 to 3 hours into the work shift (23.9%), whereas the lowest prevalence was 7 to 8 hours into the work shift (5.7%). Nine percent of all subjects reported using a different work method at the time of their injury, however there was only slight variation across the different hourly categories. In contrast, 11.5% of all subjects reported doing an unusual task at the time of their injury; however, 21.8% of subjects who were injured 7 to 8 hours into their work shift reported this exposure at the time of their injury. This was approximately twice the reporting prevalence of any other hourly period.

For exposures reported in the worker-related domain, 12.6% of all subjects reported being distracted at the time of their injury. Reports of

TABLE 2
Time into the Shift of Injury for Workers Scheduled to Work at Least 8 Hours by Gender, Day of Week, Occupational Category, Job Experience, and Job Pace

Characteristic	Time (Hours) into the Work Shift When Injury Occurred*			
	n	Mean ± SEM	Median	95% CI
Overall	981	3.7 ± 0.1	3.5	3.6–3.8
Gender				
Male	768	3.7 ± 0.1	3.5	3.5–3.8
Female	213	3.8 ± 0.1	3.5	3.5–4.1
Day of week				
Saturday/Sunday	14	4.5 ± 0.6	4.0	3.2–5.7
Monday	183	3.8 ± 0.2	3.7	3.5–4.1
Tuesday	228	3.5 ± 0.1	3.3	3.2–3.7
Wednesday	185	3.6 ± 0.2	3.3	3.3–3.9
Thursday	214	3.9 ± 0.1	3.5	3.6–4.2
Friday	157	3.8 ± 0.2	3.8	3.4–4.1
Occupational category				
Machine trades and bench work	426	3.7 ± 0.1	3.5	3.5–3.9
Service	122	3.5 ± 0.2	3.3	3.2–3.9
Construction	166	3.8 ± 0.2	3.5	3.5–4.2
Packaging and material handling	87	4.0 ± 0.2	3.8	3.5–4.4
Professional, technical, and managerial	72	3.6 ± 0.3	3.3	3.1–4.1
Clerical and sales	50	3.1 ± 0.3	2.9	2.5–3.7
Miscellaneous	58	3.9 ± 0.3	4.0	3.3–4.5
Job experience				
<1 year	243	3.8 ± 0.1	3.8	3.6–4.1
1–3 years	251	4.0 ± 0.1	3.8	3.7–4.2
>3 years	472	3.5 ± 0.1	3.3	3.3–3.7
Missing or Unknown	15	3.4 ± 0.5	3.2	2.3–4.5
Job Pace				
Self paced	667	3.7 ± 0.1	3.5	3.6–3.9
Non-self paced (machine, quota time, incentive based)	114	3.5 ± 0.2	3.2	3.1–3.9
Missing or unknown	200	3.8 ± 0.2	3.5	3.5–4.1

* Calculated as time of injury minus shift start time.

TABLE 3
Number (%) of Subjects Exposed to Transient Exposures at the Time of Injury by the Time (hour) into the Work Shift Hour of the Injury

No. Subjects Injured	Time into the Work Shift of Injury (see Fig. 2)								Anytime During First 8 h
	0–1 h 112	1–2 h 159	2–3 h 160	3–4 h 157	4–5 h 126	5–6 h 95	6–7 h 84	7–8 h 88	981
Equip/materials different	17 (15.2)	22 (14.0)	38 (23.9)	27 (17.3)	11 (8.9)	12 (12.6)	14 (16.9)	5 (5.7)	146 (15.0)
Different method	13 (11.6)	13 (8.2)	13 (8.1)	14 (9.0)	11 (8.8)	7 (7.4)	9 (10.7)	9 (10.3)	89 (9.1)
Unusual task	11 (9.8)	20 (12.6)	19 (11.9)	18 (11.5)	10 (8.0)	7 (7.4)	8 (9.5)	19 (21.8)	112 (11.5)
Distracted	13 (11.6)	16 (10.1)	17 (10.6)	19 (12.2)	16 (12.8)	18 (18.9)	11 (13.3)	13 (14.8)	123 (12.6)
Rushing	28 (25.0)	34 (21.4)	42 (26.3)	35 (22.4)	35 (27.8)	27 (28.4)	19 (22.6)	23 (26.1)	243 (24.8)
Feeling ill	3 (2.7)	2 (1.3)	5 (3.1)	3 (1.9)	4 (3.2)	4 (4.2)	1 (1.2)		22 (2.2)
No. Subjects reporting any exposure*	64 (57.1)	82 (51.6)	97 (60.6)	80 (51.0)	60 (47.6)	50 (52.6)	41 (48.8)	45 (51.1)	519 (52.9)

* Evaluated for the six listed exposures.
Note: Inclusion criteria: subjects scheduled to work at least 8 hours and injured within 8 hours into their work shift.

distraction peaked for subjects injured 5 to 6 hours into their work shift (18.9%). Twenty-five percent of subjects reported being rushed at the time of their injury, which was the exposure with the highest overall prevalence. Those injured from 4 to 5 hours (27.8%) and 5 to 6 hours (28.4%) into their work shift reported rushing most often; however, there was little variation across the hourly categories. Feeling ill was the exposure with the lowest overall prevalence (2.2%), and the percent reporting this exposure was greatest

for those injured 5 to 6 hours into their work shift (4.2%).

Discussion

In this study of 1166 workers with acute traumatic hand injury, the highest frequency of injury was observed during the period from 8:00 AM to 12:00 PM (54.6%), with a single peak hour from 10:00 to 11:00 AM (14.9%). The frequency of injury throughout the workday mirrored the distribution of workers scheduled at these hours (see Fig. 1). These findings are similar to those reported in a previous study of acute traumatic hand injury.[4,11] In that study, the majority of injuries (61%) occurred before 11:00 AM, with two distinct peaks throughout the day: the first peak occurring around 10:30 AM, whereas the second peak was between 1:00 and 3:00 PM. Other studies have observed similar trends, for example, a study examining worker injuries over a five-year period in an iron and steel mill reported two similar daytime peaks[4] and a study by Nag and Patel reported a similar pattern of injury frequency among textile workers.[12]

Our analysis of time into the work shift (restricted to 981 workers who were injured within the first 8 hours of their shift and were scheduled to work at least 8 hours on the day of their injury) revealed that the median time elapsed before an injury was 3.5 hours, with 77% of all injuries occurring within the first 6 hours of the shift. Fathallah and Brogmus[13] presented a similar distribution for hourly trends in workers' compensation claims for low-back disorders and cumulative trauma disorders. An epidemiologic survey of woodworking-related hand injuries found that 24% of injuries occurred within the first hour and 84.5% within the first 5 hours.[14] In the present study, 11.5% and 68.5% of all injuries occurred within the first hour and first 5 hours, respectively. There may be differences in the accuracy of the reported injury times between studies. For example, our injury times were reported almost immediately at the clinics, whereas the woodworking surveys were sent to the study subjects at home at a later date.

Timing of Exposure to Transient Risk Factors

We observed that the reported prevalence of some transient exposures was not uniform for subjects injured at different times in the workday. For example, in the work equipment domain, 17.7% of the 588 subjects injured in the first four hours of their shift reported unusual performing machine, tools, or materials at the time of their injury, compared to 10.7% of the 393 subjects injured from 4 to 8 hours into their work shift. This suggests either more use of machine, tools, or equipment in the earlier hours or something about the equipment is more hazardous at these times than later into the shift. For example, tasks associated with change in work processing such as machine setup may account for this observation. However, human performance can also contribute to this variation. For instance, in a field study, professional drivers were given a memory-search task under four different conditions: before work, during a day off, after 3.5 hours and after 7 hours into their normal work routine. Reaction times were longest after 3.5 hours, followed by 7 hours, and were both statistically different (longer) than before work or during a day off.[15]

Work practice factors also showed considerable variation over time. For example, 21.8% of subjects who were injured 7 to 8 hours into their work shift reported doing an unusual task at the time of injury. Perhaps some workers are left to do other workers' tasks at the end of the day for which they are not familiar. Although interesting, caution is urged in interpreting these findings until more data are available which describe in greater detail the temporal distribution of transient workplace exposures. Worker-related factors varied only slightly over time; however, both rushing and being distracted at the time of injury peaked for those injured 5 to 6 hours into their shift.

Temporal Factors and Fatigue

In the present study we examined temporal factors, which may be proxies for fatigue. Our results do not provide evidence to support "workday" fatigue as an important factor in these injuries. This is consistent with the finding that transportation-related crashes tend to peak within the first 4 hours of duty.[5] However, they are slightly different than the results of a steel plant study that reported injury frequency peaks in the third hour, but with a second peak during the seventh hour of the work shift.[3]

In the present study, neither the analysis of the time of day or time elapsed from the start of the work shift to injury supported an increase in injury frequency with an increase in work time (ie, fatigue). A possible explanation of these results, consistent with Wojtczak-Jaroszowa and Jarosz,[1] is that the ability to perform mental and physical activities is lowest in the early morning, particularly when exposure may be greatest in construction and manufacturing work. Nag and Patel[12] attributed a similar distribution of injury times to an increasing tempo within the workplace during this period in addition to accumulated fatigue over a short time period. Further analyses of the association between transient and temporal factors related to the risk of injury are warranted.

Temporal factors, such as time into the work shift, may differ importantly from an individual's perceived level of fatigue. Scales such as the Swedish Occupational Fatigue Inventory were developed to measure an individual's perceived level of energy, physical exertion or discomfort, motivation, and sleepiness.[16] A prospective cohort study of workplace injuries could be conducted using this scale to estimate

more accurately the individual effects of fatigue on workplace safety.

Limitations

Subject enrollment was limited to the hours of operation of the health care clinics involved in this study. The 16 clinics within the two health care clinic organizations had different hours of operations. All clinics were open by 8:00 AM; however, one organization closed primarily by 4:30 PM, the other closed by 6:00 PM. This may have led to an underestimate of the frequency of injuries occurring earlier or later in the day or into the work shift. However, the majority of subjects were scheduled to work during open clinics hours (see Fig. 1). Additionally, for analyses of the time-into-the-work shift we included only workers scheduled to work at least 8 hours and were injured within the first 8 hours of their work shift to prevent bias by including workers who were not at risk of injury throughout the entire 8-hour period. The results of this study should be limited to clinic-based patients with a similar spectrum of injuries employed in similar occupational categories. Thus, our results may not be generalized to sprains or more severe hand injuries treated at hospital-based emergency rooms.

Although the frequency and duration of the self-reported workplace transient exposures measured in this study were generally reliable,[9] the validity of these exposures is unknown. Subjects' recall may be inaccurate because of factors, such as "telescoping memory," where exposures closer in time to an event are recalled better,[17] or "defensive attribution," where a subject may attribute the cause of their outcome or injury to external factors.[18] Additionally, injury times in this study were self-reported at the clinic. While interviewers were asked to confirm the injury time at the start of the interview, the validity of these times is uncertain.

Conclusions

In summary, interactions between the organization of the workday and transient exposures (such as rushing and being distracted) are important in understanding the occurrence of injury in the workplace. For example, an injury may be more likely for a food service worker rushing in the early morning after an unusually long or short sleep, or for a manufacturing worker distracted while performing repairs to a jammed machine during the busiest period of the day. Temporal and transient factors may combine under different work conditions to synergistically "trigger" an injury. This concept is implicit in Haddon's[19] description of a conceptual model for studying simultaneous exposures to a host (eg, human), agent (eg, energy), vector (eg, machine), and environment (eg, sociocultural) factors in injury epidemiology. Strategies to reduce the burden of workplace injuries must consider all of these factors. For example, these data suggest evaluating various machine maintenance schedules and safety programs with emphasis on increased vigilance at times when workers are performing unusual tasks.

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