Inpatient Hospitalizations for Work-Related Injuries and Illnesses in Massachusetts, 1996-2000

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Massachusetts Department of Public Health
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Executive Summary

Analyses of Massachusetts hospital discharge data for calendar years 1996 to 2000 were performed to identify hospitalizations that were primarily for the treatment of work-related injuries and illnesses. It was hoped that examining the nature of these inpatient stays could provide information about the nature and extent of serious work-related health conditions that is not currently available from other sources. Expected payment by workers' compensation (WC) insurance was used as an indicator of probable work-relatedness of the patient's condition. Additional analyses were performed to examine data on inpatient stays that were not paid for by workers' compensation, but which involved health conditions that typically result from workplace exposure to hazardous substances. Some of the major findings of the study include:

- **There were 20,457 hospitalizations in Massachusetts for treatment of work-related injuries and illnesses paid for by workers' compensation insurance during the five-year period from 1996 through 2000.** This represented 0.56% of all hospitalizations in the state and 1.2% of hospitalizations involving working-age adults (16-64 years of age).

- **Hospital charges for treatment of work-related injuries and illnesses totaled over $266 million.** These work-related injuries and illnesses required almost 74,000 days of inpatient care, an average of 3.6 days per stay.

- **Over three-quarters of hospitalizations (77.7%) were among men and 22.3% were among women.** The mean age of a patient receiving inpatient care for a work-related condition was 43.1 years old. Only 1.3% of work-related hospitalizations were for patients younger than 20 years old and 4.8 percent were for patients age 65 or older. About 84.4% of persons hospitalized for treatment of occupational injuries or illnesses were white, 4.4% were black, and 4.4% were Hispanic.

- **Musculoskeletal disorders were the most common type of work-related condition requiring hospitalization, representing 42.5% of all inpatient stays for work-related disorders**. About half (49.2%) of these were for intervertebral disc disorders. On average, an inpatient stay for treatment of a work-related musculoskeletal disorder lasted 2.6 days and had an associated hospital charge of $11,292. Compared to hospitalizations for musculoskeletal disorders among working age (16-64 years old) patients paid for by sources other than workers' compensation, the work-related cases had a shorter average length of stay (2.6 vs. 3.6 days) and a lower average hospital charge ($11,220 vs. $13,832).

- **Acute injuries and poisonings accounted for 38.5% of all hospitalizations for work-related conditions.** On average, an inpatient stay for treatment of an acute injury or poisoning lasted 4.3 days and had an associated hospital charge of $15, 909.

- **Fractures (50.3%), sprains and strains (14.1%) and open wounds (7.8%) were the most common types of work-related injuries and poisonings requiring hospitalization**. Of these injuries, 41.5% were caused by falls and 12.2% were caused by the workers' interaction with machinery.

- **Burns had a comparatively high average hospital charge ($43,176) and length of stay (9.4 days).** Burns accounted for a disproportionately large share of the total charges for work-related injuries and poisonings. Whereas burns comprised just 5.8% of the work-related injury and poisoning cases they accounted for 13.3% of the total hospital charges for these cases.

- **Sixty-one percent of hospitalized crushing injuries, 35.5% of hospitalized amputations, and 24.0% of hospitalized burns among working-age adults (16-64 years) were work-related.** Work-related inpatient stays paid by workers' compensation comprised 7.9% of all hospitalizations for injuries and poisonings among working-age adults.

- **Hispanic patients accounted for a disproportionately high percentage of the hospitalizations for certain types of work-related injuries: 15.4% of burns, 13.9% of amputations, 11.5% of crushing injuries, and 8.7% of open wounds.** Hispanic patients accounted for 4.6% of all work-related hospitalizations and 6.5% of hospitalizations that were not work-related. This suggests that Hispanic workers are at greater risk for suffering these particular types of traumatic work-related injuries.

- **Among Massachusetts youths ages 14 to 17 years , there were 58 hospitalizations for treatment of work-related injuries and illnesses between 1996 and 2000.** About half (46%) of the work-related conditions suffered by these teens were fractures, 14% were open wounds, 10% were burns, 10% were crushing injuries, and 10% were infections.

- **Numerous hospital inpatient stays not paid for by workers' compensation had diagnoses probably or possibly resulting from occupational exposures .** These included 3,798 cases of pneumoconiosis of which 3,344 had asbestosis listed as either a primary or a secondary diagnosis. There were also 114 hospitalizations for allergic alveolitis and pneumonitis, and 637 inpatient stays resulting from unintentional exposure to chemicals of a type commonly used in industrial environments.

Data limitations should be considered in interpreting these study findings:

1) Use of payment by workers' compensation as an indicator of work-relatedness likely underestimates the true extent of hospitalizations for work-related conditions. Some individuals injured at work, including the self-employed who comprise approximately 6% of the Massachusetts workforce, are not eligible for workers' compensation insurance. Others who are eligible may not file workers' compensation claims.

2) While external cause of injury codes (E-codes) are generally accurate for broad cause of injury categories, they may be less accurate for detailed causes of injury presented in this report (i.e., falls, burns, machinery injuries).
3) Hospitalizations presented in this report may include multiple hospitalizations for single individuals. The extent of repeated hospitalizations is addressed in an Appendix to this report.

This exploratory examination of hospital discharge data has demonstrated that the data are useful in describing the nature and extent of serious work-related conditions in Massachusetts. The hospital data are readily available and contain a variety of information concerning the nature and cause of injury, patient characteristics, and types of medical services provided. Unlike many other data sources used for occupational health surveillance, the hospital discharge data set captures information about all injuries, work-related and non-work-related. It therefore allows assessment of the contribution of work-related injuries to the overall injury burden, fostering integrated approaches to prevention that cross public health disciplines (e.g. injury control and occupational health). While it is likely that not all hospitalizations for work-related conditions are identified using payment by workers' compensation as an indicator of work-relatedness, the outcomes of this study are sufficient to warrant periodic use of hospital inpatient data as a supplement to other occupational health surveillance activities.

Possible strategies for further enhancing the usefulness of hospital discharge data for occupational health surveillance include: recording and collection of information about the work-relatedness of patient's condition; recording and collection of information about the patient's activity at the time of injury; inclusion of a dedicated E-code field to capture location where injury took place; ensuring accurate "E-code" information about the external cause of injuries; expanding the collection and reporting of information about the patient's employer; and linking the hospital discharge data with workers' compensation claims data from the state Department of Industrial Accidents.

Introduction

Massachusetts' 81 acute care[1], non-federal hospitals provide over 700,000 inpatient hospital stays annually. Hospital care—including emergency, inpatient, and outpatient services—accounted for about 38% of all health care expenditures in Massachusetts in 1998.[i] Patients admitted to hospitals for inpatient care generally have more serious types of illnesses and injuries than those treated on an outpatient basis. Examining hospitalization records can thus be a useful tool for public health surveillance of serious injuries in the general population. Indeed, a variety of studies have used hospital discharge records for injury surveillance.[ii] Public health organizations have recommended expanded use of inpatient records for surveillance and early detection of many types of traumatic and non-traumatic disorders.[iii] The Massachusetts Department of Public Health has been active in this regard, having published several injury surveillance reports based on the use of inpatient data.[iv]

Few surveillance studies have previously been conducted examining hospitalizations for work-related injuries and illnesses. An analysis of 1997-1998 data from the Nationwide Inpatient Sample (NIS)—a national dataset of hospital discharge records compiled by the U.S. Agency for Healthcare Policy and Research—estimated that there were over 200,000 hospitalizations per year nationally for work-related injuries and illnesses in 1997-1998, accounting for approximately 0.62% of all inpatient admissions.[v] Based on incidence data from the U.S. Bureau of Labor Statistics, this study also estimated that about 3% of all reported occupational injuries and illnesses result in hospital admission. Most work-related admissions were found to be for treatment of musculoskeletal disorders and acute injuries.

Previous studies have suggested that hospital discharge records have potential for providing additional information about occupational injury and illness occurrence in the general population that is not available from other available data sources, such as workers' compensation claims records.[vi] Potential advantages of using hospital discharge records for occupational health surveillance include: a) extensive information on patient characteristics, diagnoses, patient co-morbidities, medical services provided, and hospital charges; b) the availability of special codes (E-codes) in the discharge record that provide information about the external cause of injuries; c) existing systems for collection of hospital discharge data by state agencies; d) large numbers of available records from which to derive statistically significant findings; and e) a low incremental cost of conducting surveillance studies using the available discharge data.

In Massachusetts, discharge records from all licensed Massachusetts acute care, non-federal hospitals are collected quarterly by the Division of Health Care Finance and Policy (DHCFP), as mandated by State Regulation 114.1 CMR 17.00, "Requirement For the Submission of Hospital Case Mix and Charge Data." The DHCFP compiles the

[1] Number of hospitals has changed over time due to hospital mergers.

discharge data into the Massachusetts Hospital Discharge Data Base (HDD), which contains patients' information including age, sex, race or ethnicity, zip code and medical chart number; administrative information including hospital charges and expected source of payment; clinical information including primary and secondary (up to 14 additional) diagnostic codes (ICD-9-CM codes), primary and secondary (up to 14 additional) procedure codes, the length of stay, and the types of services and procedures administered during the hospitalization.

This study is aimed at producing an initial set of descriptive statistics summarizing the hospital inpatient care provided for work-related injuries and illnesses in Massachusetts. Basic characteristics of inpatient care are described, and patterns of diagnoses, procedures, and hospital charges are identified. This study represents a preliminary and exploratory examination of hospital discharge data to evaluate their utility in characterizing the extent and nature of serious work-related injuries and illnesses. When appropriate, patterns of inpatient care for work-related injuries and illnesses are compared to care for non-occupational conditions. Suggestions are made for expanding and enhancing the use of HDD data in Massachusetts occupational health surveillance efforts.

Methods

This study employed HDD data covering calendar years 1996 through 2000. HDD collects data on an annual basis beginning on October 1 and ending on September 30 of each year. Therefore, HDD data for the seven-year period extending from October 1995 to September 2001 were used to describe hospitalizations occurring in the five calendar years covered by this report. There were 139 records lacking an indication of primary payer that were excluded from the study. A total of 3,668,053 hospital discharge records were included in these analyses, distributed as follows by calendar year in which the discharge occurred:

1996:	720,826
1997:	719,452
1998:	735,323
1999:	735,941
2000:	756,511

Each discharge record contains an indication of the primary and secondary expected sources of payment for the hospital stay. Generally, this information along with the other information on the discharge record is entered by hospital administrative staff, based upon information provided by the patient, providers, and insurers. There are 21 primary payer categories, one of which is "workers' compensation." For the purposes of this analysis, expected primary payment by workers' compensation insurance was used as a surrogate indicator of the work-relatedness of the patient's condition. Previous studies have demonstrated that the designation of workers' compensation payment on a hospital discharge record is a reliable indicator of the work-relatedness of an injury[vii]. Sorock et al. (1993) found that workers' compensation payer codes on the discharge records for selected injuries were strongly correlated with patient self-report of occupational causation (Kappa = .78; 95% confidence limits of 0.67 to 0.89). The sensitivity of this indicator for self-reported occupational causation was 83% and the proportion of false positives was 2%.[viii]

Each record in the HDD contains a variety of clinical and non-clinical variables for the hospital stay including principal and secondary diagnoses, principal and secondary procedures, admission source and discharge status, patient demographics, expected payment source, total charges, length of stay, and hospital characteristics. Diagnoses and procedures are coded in the HDD according to various systems including the *International Classification of Diseases, Ninth Edition*, *Clinical Modification* (ICD-9-CM) system. We converted ICD-9-CM code into the Clinical Classifications Software system (CCS)[ix] because it has more meaningful and manageable diagnostic categories. CCS, developed specifically by the U.S. Agency for Healthcare Research and Quality (AHRQ) for reporting purposes, groups ICD-9-CM codes into 259 mutually exclusive diagnostic categories and 231 mutually exclusive procedure categories. Analyses in this study employ both ICD-9-CM and CCS codes. The ICD-9-CM coding system also includes

supplementary “E-codes,” which classify injury and poisoning cases according to the external events and circumstances that caused the injury or poisoning. An E-code, for example, indicates whether a patient’s bone fracture was the result of a motor vehicle collision or a fall down a flight of stairs. Approximately 89% of the injury and poisoning discharge records contained sufficient E-code information to perform this analysis.

Univariate descriptive statistics were performed covering all diagnostic categories for work-related conditions. In addition, subgroup descriptive analyses were performed for hospitalizations involving work-related "injuries and poisonings" and for work-related "disorders of the musculoskeletal system and connective tissue." Injuries and poisonings included hospitalizations with primary ICD-9-CM diagnostic codes 800-999. Disorders of the musculoskeletal system and connective tissue included hospitalizations with primary ICD-9-CM diagnostic codes 710-739. Nature of injury and body part affected were classified according to the Barell Injury Diagnosis Matrix which is based on the ICD9 coding system. A description of the Barell Injury Diagnosis Matrix is available at: http://www.cdc.gov/nchs/about/otheract/ice/barellsas.htm. For injuries and poisonings, the International Collaborative Efforts (ICE) proposed matrix table was used to cross-reference external cause of injury (E-) codes with an indication as to whether or not the injury was intentionally inflicted. Information on ICE is available at http://www.cdc.gov/nchs/about/otheract/ice/matrix.htm.

Most of the statistical results presented in this report use a hospital “inpatient stay” as the basic unit of analysis. All inpatient stays involve a hospital admission and a hospital discharge and thus the number of inpatient stays, admissions, and discharges is equivalent. In this report, the terms “hospitalization,” “inpatient stay,” “admission,” and “discharge” will be used interchangeably when referring to the number of inpatient hospitalizations. A proportion of the hospitalizations (approximately 18%) are the result of a repeat hospitalizations by the same patients and, thus, the number of distinct patients and inpatient stays are not identical. (see Appendix A.)

Some patients admitted to Massachusetts' hospitals did not live in Massachusetts. For this study, analyses were restricted only to Massachusetts residents. Massachusetts residency was assigned by the zip code of the residential address given for the patient. Treatment for work-related injuries and illnesses can potentially occur among a wide variety of age groups including youths ages less than18 as well as elderly patients over age 65, although the vast majority of inpatient stays paid by workers' compensation (more than 94%) are for patients between 16 and 64 years old. To describe the entire spectrum of work-related hospitalizations, we used discharge records for all age ranges.

By contrast, hospitalizations for general non-occupational conditions involve large proportions of children and elderly patients (e.g., almost 55% of non-occupational hospitalizations are for people 65 or older). Therefore, when comparing hospitalizations for work-related conditions (paid for by workers' compensation) to inpatient stays for other types of non-work-related conditions in this report, we restricted the data to patients of typical working age, 16 to 64 years old.

Average annualized hospital admission rates for patients with work-related conditions were calculated as the number of inpatient stays per 100,000 Massachusetts workers. Annual workforce estimates for Massachusetts for 1996 to 2000 were obtained from the Massachusetts Department of Employment and Training, based on responses to the Current Population Survey (see http://massstats.detma.org/websaras/frame_it.asp?theProductName=MassStats). These workforce estimates include the self-employed who typically are not covered by workers' compensation. Self-employed workers comprised approximately 6.4% of the Massachusetts workforce in 2000.

Occupational illnesses are thought by most authorities to be less accurately reflected in workers' compensation data than are occupational injuries, and thus hospitalizations for work-related illnesses are likely to be substantially underestimated when using expected payment by workers' compensation as the indicator of work-relatedness. To assess the potential extent to which illnesses may be associated with exposure to chemicals in the workplace, we identified all hospitalizations, irrespective of payer, in which either the patient's primary or any secondary diagnosis involved a condition arising out of contact with a substance known to be commonly found in working environments. These diagnoses included ICD-9-CM codes 980-989 (toxic effects resulting from chemical exposures - excluding intentional poisonings) and selected respiratory conditions including pneumoconioses, allergic alveolitis and lung cancer in combination with asbestosis.

Limitations

Several limitations should be considered when interpreting the information provided in this report. Indication of expected primary payment by workers compensation is not an exact representation of work-relatedness of cases for a variety of reasons: a) evidence suggests that a sizable proportion (most estimates range from 20 to 30%)[x] [xi] of work-related injuries and illnesses are not reported to workers' compensation insurers; b) hospital administrative staff may not have sufficient information upon which to make an accurate determination of expected payment by workers' compensation; and c) determinations about payment by workers' compensation may change after discharge from the hospital because of insurance or legal exigencies. While studies suggest that both the sensitivity and specificity of workers' compensation payment as a marker for work-relatedness is reasonably strong, there is not a perfect correspondence; the discharge record's indication of payment by workers' compensation likely underestimates the true extent of hospitalizations for occupational injuries and illnesses.

The accuracy of E-codes must be considered in interpreting cause of injury results. The accuracy of E-codes for hospitalized injuries may vary by hospital, type of injury, and primary and contributing injury causes. In a number of studies, E-codes have been found to be 50-85% accurate at the four-digit level[xii]. A recent study completed by MDPH found E-codes assigned in emergency departments to be approximately 60% accurate at the detailed level, but much better (85% correct) when considered within the broader external

cause of injury categories used in this report. Thus, E-codes are a valid source of information on broadly defined causes of injury.

One of the notable shortcomings of the HDD data for occupational surveillance purposes is that hospital discharge records do not include information about the patient's employment circumstances including current employer, type of occupation or industry, or information about past hazard exposure. Similarly, the discharge record does not contain outcome information concerning the patient's recovery, return-to-work, and post-hospitalization vocational function. The absence of these data limits our ability to learn about the relationships between the patient's condition and employment characteristics that could be important from a prevention standpoint.

The financial information contained in this report should also be interpreted with caution insofar as only hospital charge information is available from the discharge record. Typically, actual costs differ from hospital charges because of the prevailing reimbursement rates, discounting, and other factors. Overall in Massachusetts in 2001, the ratio of costs to charges for hospital inpatient care was approximately 55%, and that ratio varied significantly among hospitals.[xiii] Additionally, hospitals' direct charges or costs may not include either physician's fees billed directly by the treating physician or medical costs incurred for outpatient care prior to admission or after discharge. The hospital costs also exclude other direct or indirect costs borne by the patient, patient's family, employer and others.[xiv] In general, then, hospital charges should be interpreted only as a general indicator of the hospital's true costs and as only a part of the overall medical and social costs related to the patient's condition.

In this report, comparisons between hospitalizations for work-related conditions paid for by workers' compensation and non-work-related conditions paid for by sources other than workers' compensation are made on the basis of raw data, restricted by patients' age range as mentioned above. Comparisons did not control for the influence of other factors—such as gender, co-morbidities, and severity—which potentially could affect the comparisons between Workers' Compensation (WC) and non-Workers' Compensation (non-WC) cases. More extensive multivariate analysis would be needed to examine these issues in depth.

Results

Extent of Inpatient Stays for Work-Related Conditions

From 1996 to 2000, there were 20,457 admissions to Massachusetts acute care, non-federal hospitals for treatment of work-related injuries and illnesses paid for by workers' compensation insurance (Table 1). This represented approximately 0.56% of all hospitalizations in the state during that period and 1.2% of hospitalizations involving working age patients (16-64 years of age). As a proportion of the state labor force, the admission rate varied from a low of 133.2 admissions per 100,000 workers in 1998 to a high of 153.8 per 100,000 workers in 1996 (Table 2). Combining these findings with information about reported workplace illnesses and injuries from the U.S. Bureau of Labor Statistics' Survey of Occupational Injuries and Illnesses suggests that about 3.2% of all occupational conditions in Massachusetts resulted in hospital admissions (Table 3). Over the five-year period, the number of hospital inpatient stays for work-related conditions remained relatively stable (and fell slightly from 1996 to 1997), while the number of inpatient stays for non-work-related conditions increased slightly (Figure 1).

Table 4 shows the geographical distribution of inpatient stays by county of patient's residence, for work-related and non-work-related conditions. Middlesex County accounted for the largest proportion of inpatient admissions for work-related conditions (16.8% of total), followed by Worcester County with 13.8%. The admission rate per 100,000 workers for patients with work- related conditions varied considerably by county, possibly because of county variations in the mix of employers and the corresponding risk of exposure to occupational hazards. Barnstable, Berkshire, Bristol, Hampden, Plymouth and Worcester counties had admission rates that were substantially higher than the state average, while Hampshire, Middlesex, and Essex counties had relatively lower hospital admission rates per 100,000 workers.

Table 1. Inpatient hospital stays, by WC payment, by year, MA, 1996-2000

Calendar Year	Expected payer WC[a]	Expected payer Other than WC[a]	WC[a] as % of Total	Total
1996	4,404	716,422	0.61	720,826
1997	4,022	715,430	0.56	719,452
1998	3,967	731,356	0.54	735,323
1999	4,003	731,938	0.54	735,941
2000	4,061	752,450	0.53	756,511
Total	20,457	3,647,596	0.56	3,668,053

[a] Workers' Compensation Insurance

Table 2. Rate of work-related inpatient stays per 100,000 workers, MA, 1996-2000

Calendar Year	Work-Related Inpatient Stays	Average MA Employment[a]	Admission Rate per 100,000 Workers
1996	4,404	3,201,430	153.8
1997	4,022	3,296,936	135.3
1998	3,967	3,307,833	133.2
1999	4,003	3,297,030	134.3
2000	4,061	3,267,018	137.0
Total	20,457	16,370,247	138.6

[a] Massachusetts workforce estimates from Current Population Survey. [xv]

Table 3. Rate of work-related inpatient stays per 100 occupational injuries and illnesses, MA, 1996-2000

Calendar Year	Work-Related Inpatient Stays	BLS Reported Occupational Injuries and Illnesses[a]	Admission Rate per 100 Occupational Injuries & Illnesses
1996	4,404	131,900	3.3
1997	4,022	124,300	3.2
1998	3,967	130,000	3.1
1999	4,003	130,500	3.1
2000	4,061	132,200	3.1
Total	20,457	648,900	3.2

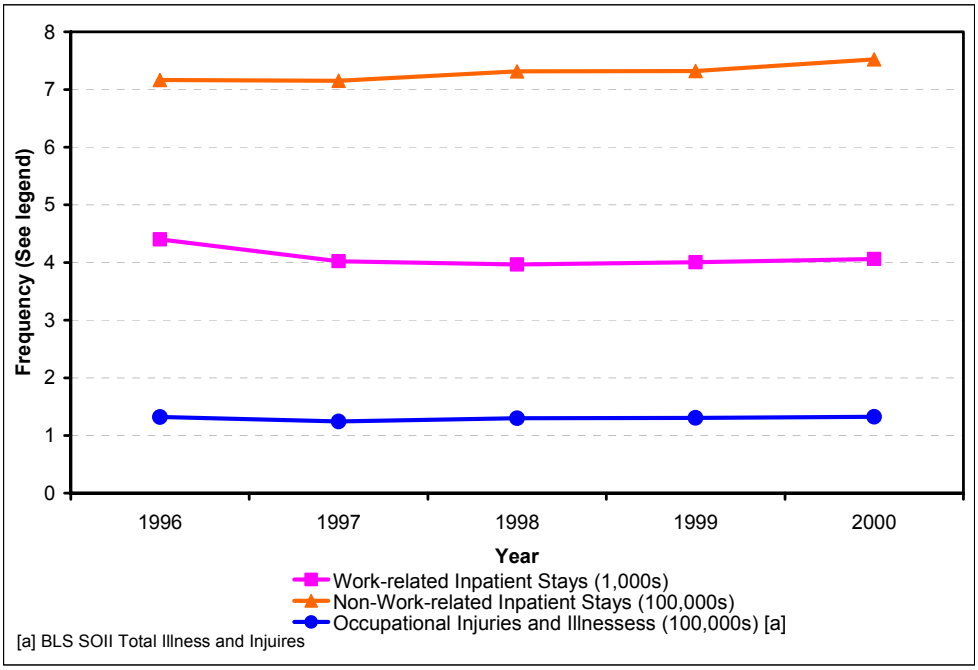
[a] U.S. Bureau of Labor Statistics. *Nonfatal Occupational Injury and Illness Reports, 1996-2001*. Available at: http://www.bls.gov/iif/oshsum.htm[xvi]

Table 4. Distribution of inpatient stays, workforce, and work-related hospitalization admission rates, by county of patient's residence, MA, 1996-2000

County of Patient's Residence	Percent of Massachusetts Workforce[a]	Number of Work-Related Inpatient Stays	Percent of Work-Related Inpatient Stays	Percent of Non-work-Related Inpatient Stays	Work-Related Admission Rate per 100,000 Workers
Barnstable	3.2	896	4.4	3.4	178.7
Berkshire	2.0	717	3.5	2.5	230.0
Bristol	7.9	1,761	8.6	8.0	141.0
Dukes	0.3	47	0.2	0.2	106.3
Essex	11.2	1,982	9.7	11.6	93.4
Franklin	1.2	189	0.9	1.0	103.7
Hampden	6.4	1,668	8.2	8.3	165.9
Hampshire	2.5	148	0.7	0.8	37.7
Middlesex	25.1	3,440	16.8	19.4	86.9
Nantucket	0.2	44	0.2	0.1	143.9
Norfolk	11.1	2,120	10.4	9.4	121.9
Plymouth	7.5	1,822	8.9	6.4	155.4
Suffolk	10.3	1,983	9.7	12.0	121.5
Worcester	11.3	2,832	13.8	11.7	160.3
Unknown		808	3.9		
Total	100.0	20,457	100.0	100.0	125.9

[a] Massachusetts Division of Career Services and the Division of Unemployment Assistance. *Massachusetts Civilian Labor Force Statistics*. [xvii]

Figure 1. Five-year trends in occupational injury and illness incidence, and inpatient stays by Workers' Compensation payment, MA, 1996-2000



Characteristics of Patients Hospitalized for Work-Related Conditions

Approximately 95% of patients hospitalized for treatment of work-related conditions were between 16 and 64 years of age, and a majority of them (55.5%) were between 35 and 54 years old (Figure 2). Few patients with work-related conditions were less than 16 years old (0.1%) or more than 64 years old (4.8%). Figure 3 provides a comparison of the age distribution for working age adults (16-64 years old) hospitalized for work-related and non-work-related disorders. Patients with non work-related conditions were more likely to be in the younger (16-24) and older segments (55-64) of the age range compared to those with work-related ailments.

Most patients hospitalized for treatment of work-related conditions were men (77.7%) (Figure 4). Additionally, the inpatient admission rate per 100,000 workers each year was considerably higher for men (188.7) than for women (59.2), presumably reflecting the concentration of men in more hazardous jobs (Figure 5). By contrast, women comprised the majority (63.4%) of working-age adults hospitalized for non-work-related conditions[2].

Figure 6 portrays the racial and ethnic distribution of patients hospitalized for work-related conditions. The vast majority of them (84.4%) were white; 4.4% were black and 4.4% were Hispanic[3]. Admission rates for treatment of work-related conditions were generally higher among Hispanic than among non-Hispanic patients, especially in some diagnostic groupings such as traumatic injuries, burns, and amputations (Table 5). Figure 7 depicts the comparative racial and ethnic distribution of working-age patients (age 16-64) hospitalized for treatment of work-related and non-work-related conditions. In general, these distributions were similar, although non-white minority groups were somewhat less likely to be hospitalized for work-related than for non-occupational conditions.

[2] Massachusetts workforce is 51.4% male; 48.6% female. US Census, 2000.
[3] Massachusetts workforce is 81.4% white, 5.4% black, and 6.6% Hispanic. US Census 2000.

Figure 2. Age distribution of patients hospitalized for treatment of work-related conditions, MA, 1996-2000, n= 20,457

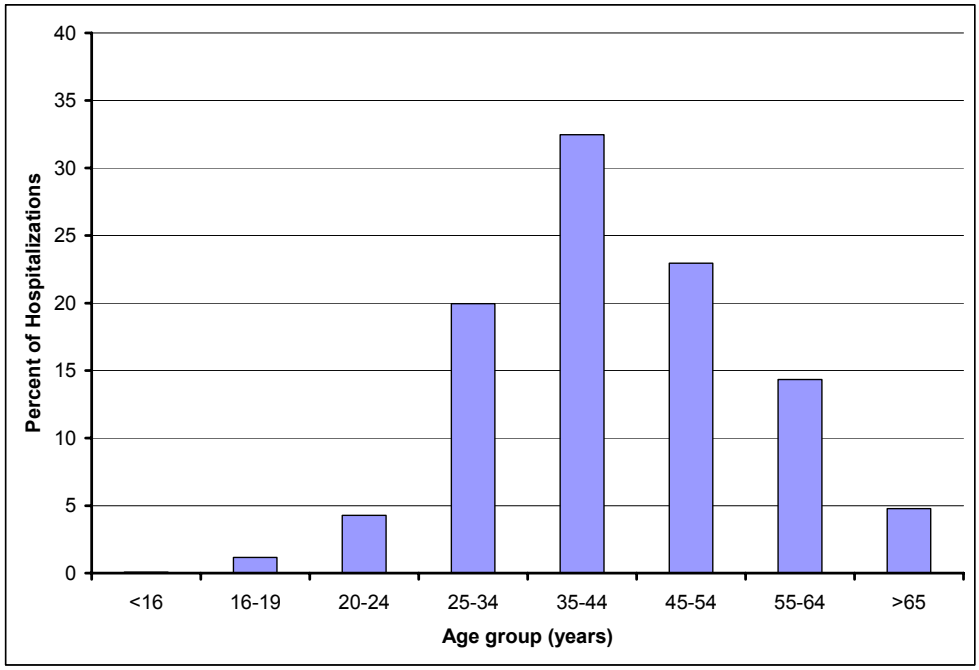


Figure 3. Comparative age distribution of working-age patients (age 16-64) hospitalized for treatment of work-related and non-work-related conditions, MA, 1996-2000, n= 19,464 (WC), n= 1,643,949 (non-WC)

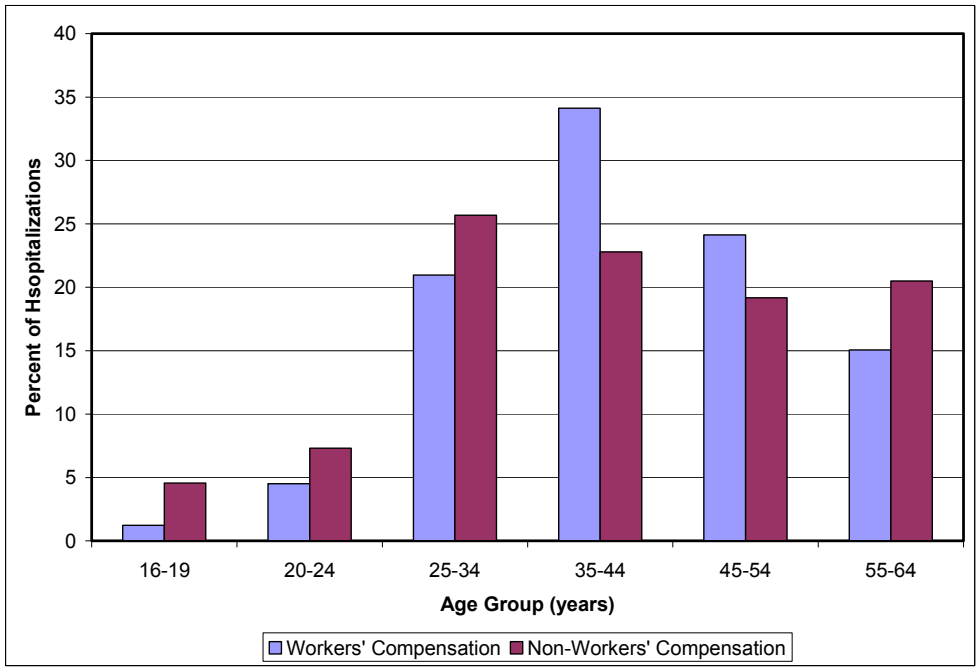


Figure 4. Gender distribution of patients hospitalized for work-related conditions, MA, 1996-2000. n= 20,457

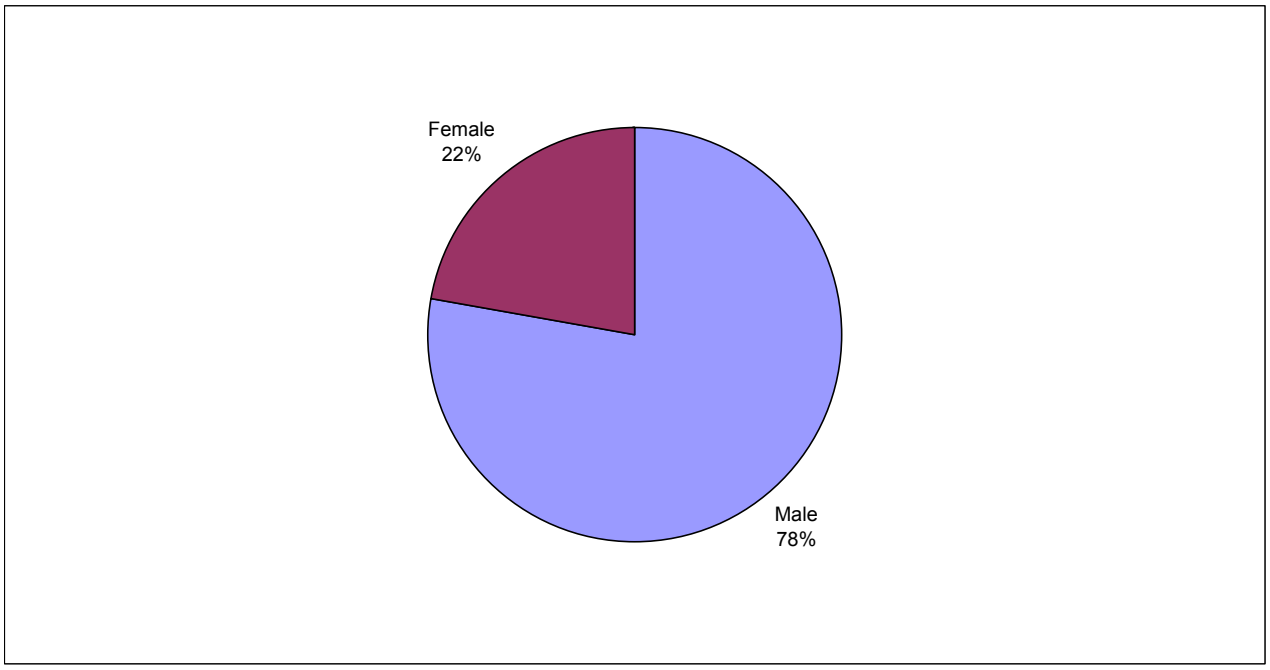
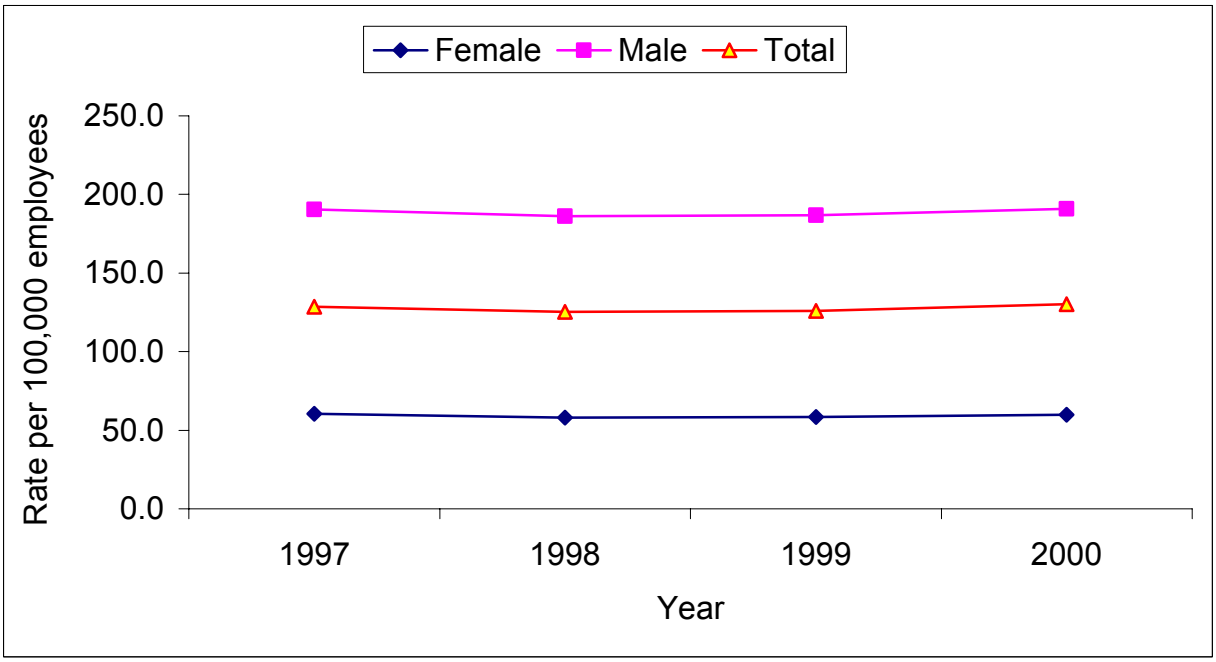


Figure 5. Admission rates of work-related cases by gender, by year, MA, 1997-2000[a]



[a] Massachusetts workforce estimates from Current Population Survey.[xviiii] Data not available for 1996.

Figure 6. Racial and ethnic distribution of patients hospitalized for work-related conditions, MA, 1996-2000. n= 20,457.

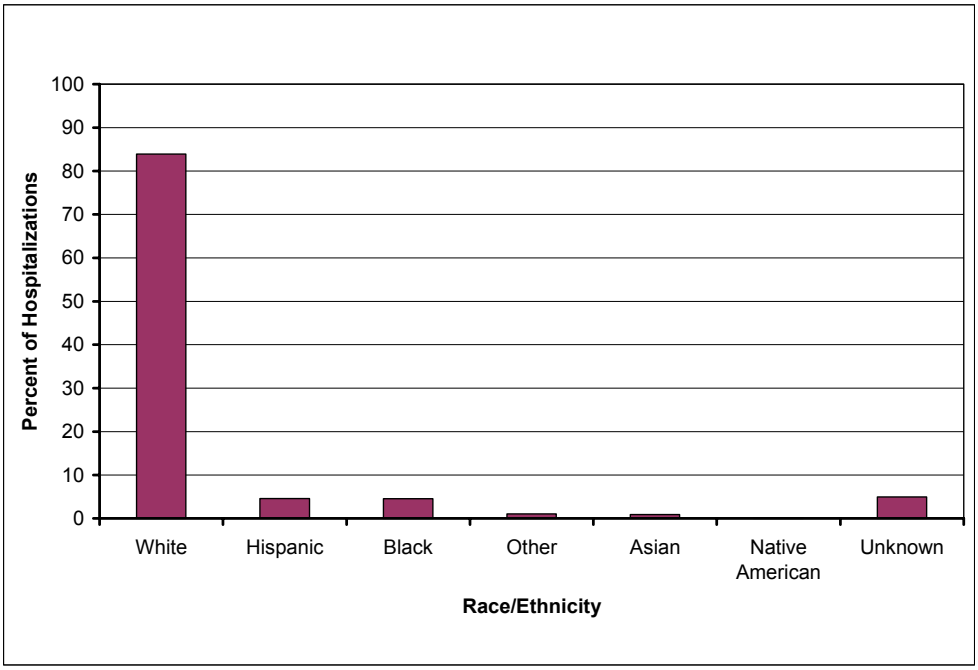
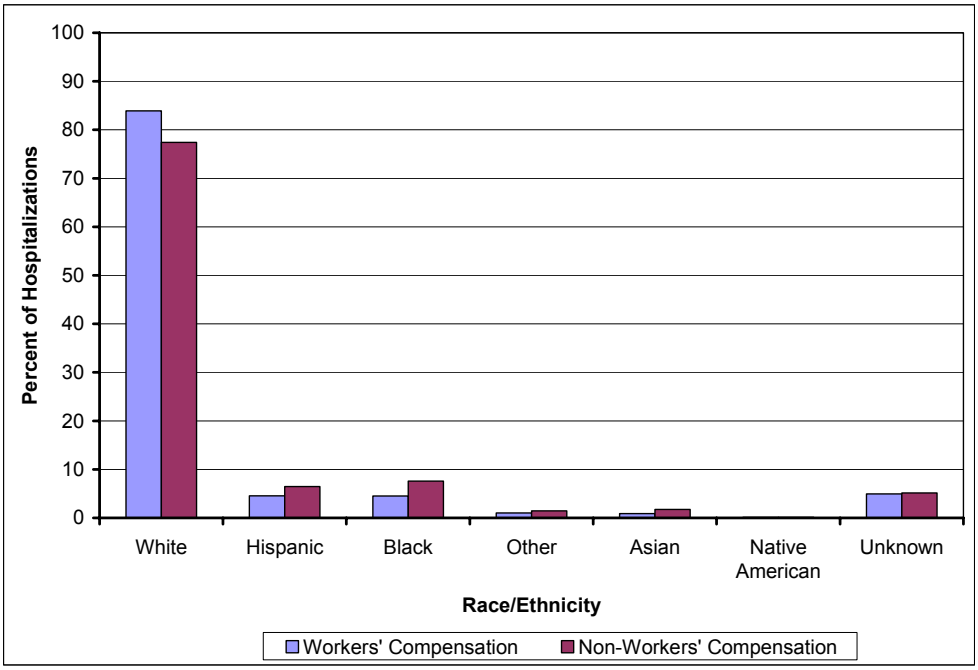


Table 5. Comparative admission rates per 100,000 workers for patients with selected types of work-related conditions, by Hispanic ethnicity, MA, 1997-2001[a], n= 20,457

	All Causes	Injury	Burn	Amputation
Hispanic	124.0	54.8	8.0	4.6
Non-Hispanic	139.3	43.8	2.3	1.5
Total	138.6	44.4	2.6	1.6

[a] Massachusetts workforce estimates from Current Population Survey.[xix]

Figure 7. Comparative racial distribution of working-age patients (age 16-64) hospitalized for treatment of work-related and non-work-related conditions, MA, 1996-2000, n= 19,461 (WC), n= 1,643,751 (non-WC)



Diagnostic Classification of Work-Related Inpatient Stays

The overwhelming majority (81%) of hospital inpatient stays for work-related conditions were either for disorders of the musculoskeletal system and connective tissue, or for traumatic injuries and poisonings (Table 6). Disorders of the musculoskeletal system and connective tissue disorders accounted for 42.5% of WC cases, followed by injury and poisoning (38.5%) and circulatory system disorders 4.5%). Occupational illnesses comprised less than 20% of the hospitalizations. However, occupational illnesses are thought by most authorities to be less accurately reflected in workers' compensation data than are occupational injuries, and thus hospitalizations for work-related illnesses are likely to be substantially underestimated by these data.

The CCS codes provide a more detailed breakdown of diagnostic categories than do the broad ICD-9-CM classifications. Table 7 provides information concerning the distribution of work-related hospitalizations among the twenty most commonly reported CCS diagnostic classifications. Spondylosis, intervertebral disc disorders, other back problems was the most frequent category, representing more than a quarter of the inpatient stays. Fractures of the lower limbs were next, accounting for 7.5%, followed by other connective tissue disease (4.6%).

The distribution of diagnoses among people hospitalized for work-related conditions was dramatically different than among other working-age adults hospitalized for non-occupational conditions. Among the latter group, the most common diagnostic categories included pregnancy and childbirth (25.4% of inpatient stays), mental disorders (12.6%), and diseases of the circulatory system (10.4%).

Table 6. Distribution of inpatient stays for work-related conditions by primary diagnostic grouping, MA, 1996-2000

Diagnostic Group (ICD-9)	Number	Percent
Musculoskeletal system disorders	8,699	42.5
Injury and poisoning	7,875	38.5
Circulatory system disorders	922	4.5
Skin disorders	757	3.7
Nervous system disorders	416	2.0
Ill defined symptoms	401	2.0
Digestive system disorders	394	1.9
Respiratory system disorders	277	1.4
Mental disorders	143	0.7
Other	573	2.8
All Diagnostic Groups	20,457	100.0

Table 7. Distribution of the 20 most frequent primary CCS diagnostic codes for inpatient stays involving work-related conditions, MA, 1996-2000

CCS Diagnostic Groups	Frequency	
	Number	Percent
Spondylosis, intervertebral disc disorders, other back problems	5,296	25.9
Fracture of lower limb	1,537	7.5
Other connective tissue disease	932	4.6
Sprains and strains	924	4.5
Fracture of upper limb	819	4.0
Complication of device, implant or graft	774	3.8
Joint disorders and dislocations, trauma-related	751	3.7
Skin and subcutaneous tissue infections	621	3.0
Open wounds of extremities	614	3.0
Complications of surgical procedures or medical care	600	2.9
Osteoarthritis	589	2.9
Other non-traumatic joint disorders	516	2.5
Other fractures	434	2.1
Burns	379	1.9
Crushing injury or internal injury	377	1.8
Other nervous system disorders	329	1.6
Intracranial injury	329	1.6
Other bone disease and musculoskeletal deformities	328	1.6
Fracture of neck of femur (hip)	313	1.5
Other injuries and conditions due to external causes	263	1.3

Length of Stay for Work-Related Hospitalizations

More than one-third (34.4%) of hospitalizations for work-related conditions lasted for only one day and two-thirds of inpatient stays (67.9%) were for three days or less (Figure 9). The mean length of an inpatient stay was 3.6 days, and the median length of stay was 2.0 days.

The mean length of stay for work-related hospitalizations varied considerably by diagnosis, with inpatient stays for patients with musculoskeletal disorders having a relatively short mean duration (2.6 days) and patients with injuries, poisonings, and systemic diseases typically staying much longer (ranging from a mean of 4.3 to 6.9 days) (Table 8). Similar variations were observed among the top twenty CCS diagnostic groupings, with the mean length of stay ranging from 1.8 days for strains and sprains and other non-traumatic joint disorders to 9.4 days for burn injuries (Table 9). Among all types of work-related conditions, inpatient rehabilitation care for the fitting of prostheses and adjustment of devices required the longest average length of stay (14.5 days; n=103) followed by burns (9.4 days; n= 379), and infective arthritis and osteomyelitis (7.0 days; n=157).

Figure 8. Distribution of length of stay for hospitalizations involving work-related conditions, MA, 1996-2000, n= 20,457

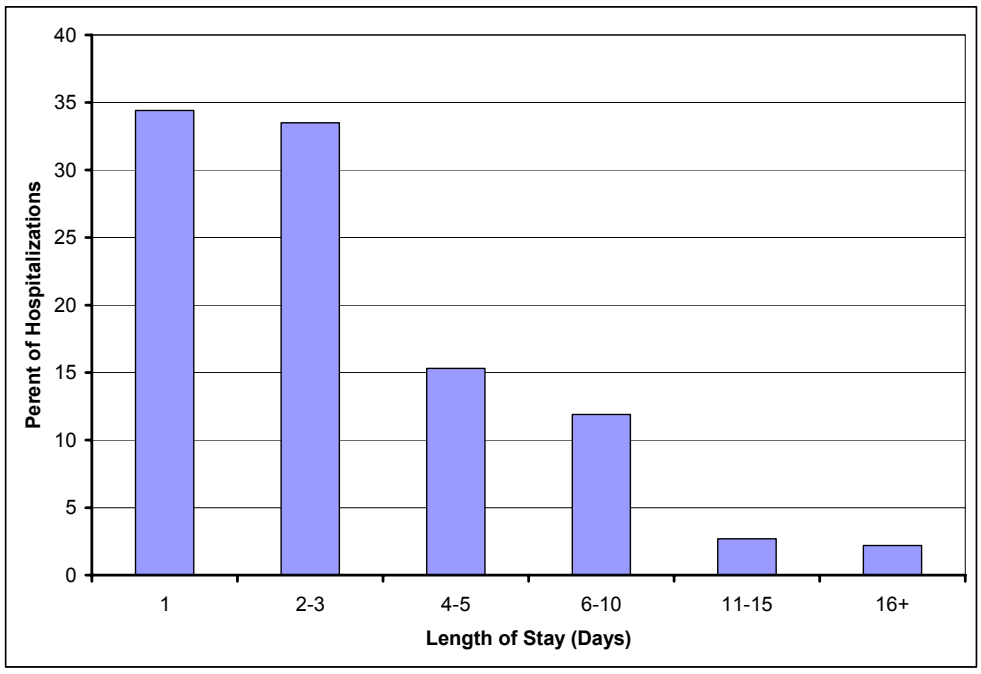


Table 8. Mean length of stay by primary ICD-9-CM diagnostic category for inpatient stays involving work-related conditions, MA, 1996-2000

Diagnostic Group (ICD-9)	Mean Length of Stay (Days)	N
Musculoskeletal system disorders	2.6	8,699
Injury and poisoning	4.3	7,875
Circulatory system disorders	4.6	922
Skin disorders	4.8	757
Nervous system disorders	3.4	416
Ill defined symptoms	2.3	401
Digestive system disorders	3.6	394
Respiratory system disorders	6.7	277
Mental disorders	6.9	143
Other	Not determined	573
Total	3.6	20,457

Table 9. Mean length of stay for the 20 most frequent primary CCS diagnostic codes for inpatient stays involving work-related conditions, MA, 1996-2000

CCS Diagnostic Groups	Mean Length of Stay (days)	N
Spondylosis, intervertebral disc disorders, other back problems	2.5	5,296
Fracture of lower limb	4.3	1,537
Other connective tissue disease	2.0	932
Sprains and strains	1.8	924
Fracture of upper limb	2.9	819
Complication of device, implant or graft	5.0	774
Joint disorders and dislocations, trauma-related	2.0	751
Skin and subcutaneous tissue infections	4.0	621
Open wounds of extremities	3.3	614
Complications of surgical procedures or medical care	4.9	600
Osteoarthritis	4.0	589
Other non-traumatic joint disorders	1.8	516
Other fractures	5.1	434
Burns	9.4	379
Crushing injury or internal injury	5.7	377
Other nervous system disorders	2.9	329
Intracranial injury	6.6	329
Other bone disease and musculoskeletal deformities	2.7	328
Fracture of neck of femur (hip)	5.9	313
Other injuries and conditions due to external causes	2.5	263
All diagnoses	3.6	20,457

Hospital Charges for Work-Related Inpatient Stays

Hospital charges for all work-related inpatient stays for the 5-year period totaled $266.4 million (Table 10). Hospital charges are typically larger than the final payments for hospital services after discounts and other adjustments. Conversely, hospital charges do not reflect amounts that are billed directly to physicians and other providers and other direct costs to the patient. However, hospital charges can be used as a general indicator of the true costs. Charges for work-related injuries and poisonings were $123 million, accounting for 46.2% of all charges, despite representing only 38.5% of all work-related inpatient stays (see Table 6). Hospitalizations for patients with work-related disorders of the musculoskeletal system comprised 36.9% all hospital charges. Combined with injuries and poisonings, these two ICD-9-CM groupings accounted for 83% of all hospital charges paid by workers' compensation. Hospital charges for work-related circulatory system cases were $14 million, representing 5.5% of all hospital charges during the five year period.

The average total hospital charge for an inpatient stay for treatment of a work-related condition was $13,022 (Table 10). Among the twenty most frequently treated CCS codes, burns were the most expensive disorder to treat with an average total hospital charge of $43,176 per stay, followed by intracranial injuries (mean of $27,242 per stay) and crushing or internal injuries (mean of $20,280 per stay) (Table 11).

Table 10. Mean hospital charges and total charges for inpatient stays involving work-related conditions, by ICD-9-CM diagnostic categories, MA, 1996-2000

ICD-9-CM Group	Number	Mean Charge (dollars)	Total Charges (dollars)	Percent of Total Charges
Injury and poisoning	7,875	15,643	123,185,709	46.2
Musculoskeletal system disorders	8,699	11,292	98,226,773	36.9
Circulatory system disorders	922	15,909	14,667,736	5.5
Skin disorders	757	7,363	5,573,563	2.1
Nervous system disorders	416	10,564	4,394,859	1.7
Respiratory system disorders	277	15,349	4,251,741	1.6
Digestive system disorders	394	10,250	4,038,600	1.5
Ill defined symptoms	401	6,221	2,494,472	0.9
Other categories	19,741	13,378	256,833,453	96.4
All diagnoses	20,457	13,022	266,398,701	100.0

Table 11. Mean hospital charges for the twenty most frequently treated primary CCS diagnostic codes for inpatient stays involving work-related conditions, MA, 1996-2000

CCS Diagnostic Groups	Mean Hospital Charges (dollars)	Percent of Work-Related Total Charges	Percent of Work-Related Inpatient Stays
Burns	43,176	6.1	1.9
Intracranial injury	27,242	1.3	1.6
Crushing injury or internal injury	20,280	2.9	1.8
Complication of device, implant or graft	18,080	5.3	3.8
Fracture of neck of femur (hip)	17,010	2.0	1.5
Other fractures	17,002	2.8	2.1
Osteoarthritis	16,604	3.7	2.9
Fracture of lower limb	14,478	8.4	7.5
Open wounds of extremities	13,424	3.1	3.0
Other bone disease and musculoskeletal deformities	13,207	1.6	1.6
Fracture of upper limb	12,588	3.9	4.0
Spondylosis, intervertebral disc disorders, other back problems	11,046	22.0	25.9
Other nervous system disorders	10,365	3.4	1.6
Complications of surgical procedures or medical care	10,045	2.3	2.9
Joint disorders and dislocations, trauma-related	9,856	2.8	3.7
Other non-traumatic joint disorders	9,441	1.8	2.5
Other injuries and conditions due to external causes	8,639	0.9	1.3
Other connective tissue disease	7,407	2.6	4.6
Sprains and strains	7,356	2.6	4.5
Skin and subcutaneous tissue infections	5,557	1.3	3.0
All diagnostic groups	13,022	100.0	100.0

Hospitalizations for Work-Related Injuries and Poisonings

Approximately 38.5% of work-related inpatient stays were for treatment of injuries and poisonings (ICD-9-CM codes 800-999). Of the work-related injury and poisoning cases, 83.2 % (6,551 of 7,875) could be classified by nature of injury. The remaining 16.8% were Classified as "Certain adverse effects not elsewhere classified" (ICD-9-CM code 995) or as "Complications of surgical and medical care, not elsewhere classified" (ICD-9-CM codes 996-999). Among the injuries classified by nature of injury, fractures were the most common type (41.8% of work-related injuries and poisonings), followed by sprains and strains (11.7%) and open wounds (6.5%) (Table 12). Only 2.5% of these cases involved systemic effects or poisoning. Nearly three-quarters (71.9%) of the work-related injuries and poisoning affected the patients' lower or upper extremities (Figure 9). As depicted in Figure 10, treatment for work-related injuries and poisoning constituted about 7.9% of the inpatient stays for injuries and poisoning in Massachusetts during 1996-2000 among working-age adults (16-64 years old). The proportion of hospitalizations for injuries and poisonings that were for work-related conditions paid through workers' compensation varied from 60.9% for crushing injuries and 35.5% for amputations to 1.1% for systemic effects or poisoning.

Among hospitalizations for work-related injuries and poisonings, the proportion that were sprains and strains increased with patient age, whereas the proportion that were open wounds, amputations, crushing injuries, and burns decreased with patients' age (Figure 11). This may reflect that younger workers are exposed to more dangerous working environments or that younger workers are at greater risk due to inexperience and developmental factors.

More than 80% of hospitalizations for work-related injuries and poisoning involved white workers. However, the racial and ethnic distribution of patients hospitalized for work-related injuries and poisonings varied by injury type. Hispanic workers were involved in a disproportionately high number of hospitalizations for burns, amputations, and open wound injuries (Figure 12). This is consistent with evidence suggesting that Hispanic workers are more likely to be exposed to relatively dangerous working environments in which these injuries are apt to occur.[xx] The two injury categories with the largest proportion of minority patients were burns and amputations, for which about 30% of patients were non-white, again suggesting that minority workers are at greater risk of suffering these severe injuries.

Approximately 81% of the hospital discharge records for work-related injuries and poisonings included "E-codes" which specify the external cause of injury (Table 13). Based on E-codes, the most common causes of injury leading to hospital admissions for work-related injuries were falls (41.5%) and contact with machinery (12.2%). Of all the injury hospitalizations in Massachusetts caused by falls, 10.6% were work-related, and of those caused by contact with machinery, 64.5% were work-related.

Among the work-related injury and poisoning cases, the vast majority (71.9%) involved injuries to the lower (38.9%) or upper (33.0%) extremities. Of hospitalized cases for injuries to the lower extremity, most (53.8%) were caused by falls. Of the upper extremity injuries, most were caused either by contact with machinery (26.4%) or by falls (25.6%). Seventy percent of the work-related machinery injuries involved the patient's upper extremities, and 93.3% of all work-related amputations involved the upper extremities. Falls were the cause of 57 % of all traumatic brain injuries, 47% of spinal cord injuries, 57% of vertebral column injuries, and 46% of torso injuries among the work-related injury and poisoning cases.

Table 12. Inpatient stays for work-related injuries and poisonings, by type of injury or poisoning MA, 1996-2000,

Nature of injury	Frequency	Percent
Fractures	3,294	50.3
Sprains & strains	924	14.1
Open wound injury	513	7.8
Internal organ injury	471	4.7
Burns	379	5.8
Amputation	241	3.7
Systemic effects & poisonings	196	3.0
Dislocation	147	2.2
Crushing injury	131	2.0
Superficial/contusion	101	1.5
Nerve injury	67	1.0
Blood vessel injury	39	0.6
Unspecified	48	0.7
Total Classified	6,551	100.0
Not elsewhere classified[a]	1,324	
Total	7,875	

[a] 1,324 injury and poisoning cases had nature of injury codes of "Certain adverse effects not elsewhere classified" (ICD-9-CM code 995) or as "Complications of surgical and medical care, not elsewhere classified" (ICD-9-CM codes 996-999) that could not be classified into one of these categories.

Figure 9. Percent distribution inpatient visits for treatment of work-related injuries and poisonings, by effected body part, 1996-2000, n=6,548[a]

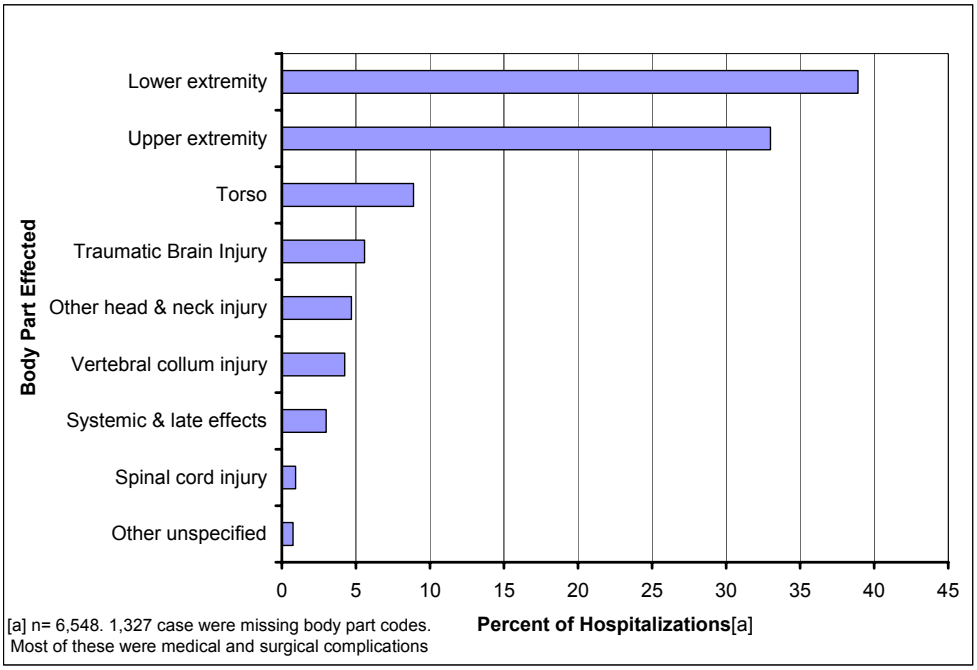


Figure 10. Inpatient stays for work-related injuries and poisonings, by type of injury, as a percentage of all inpatient injuries and poisonings for working-age adults, 16-64 years old, 1996-2000, n=6,253[a]

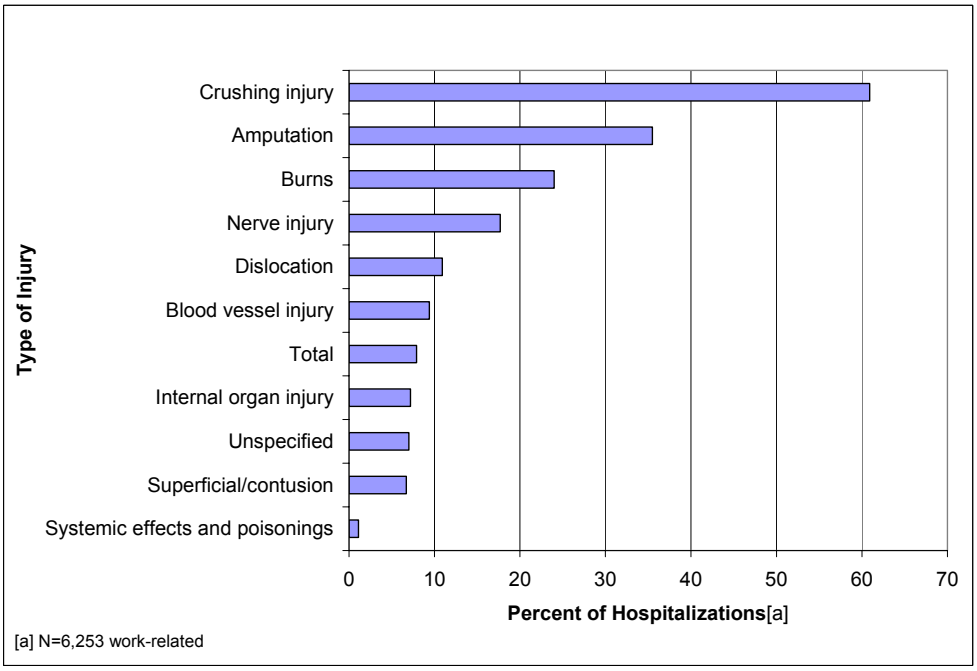
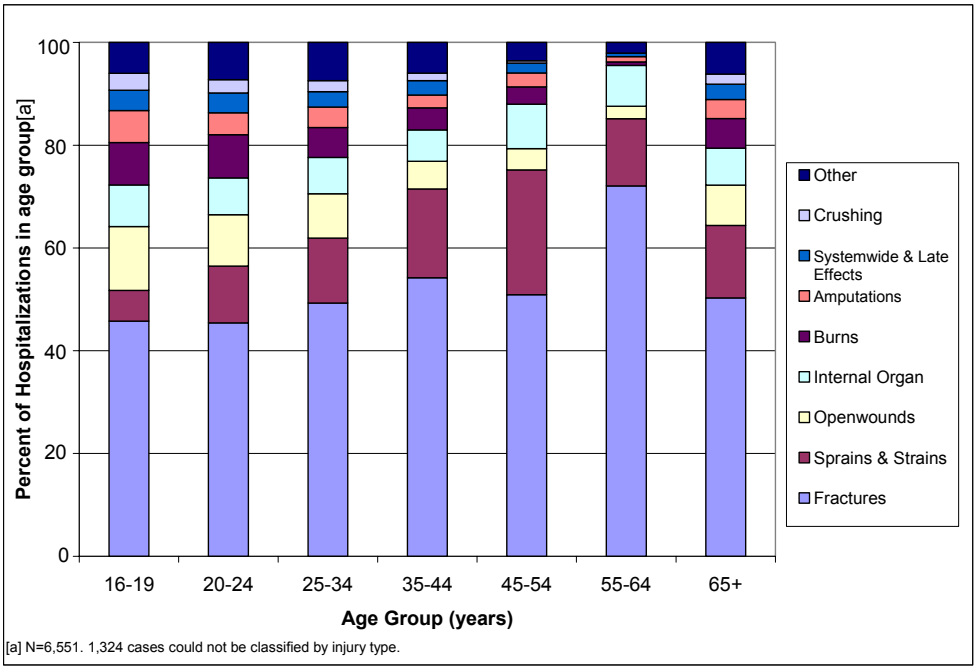
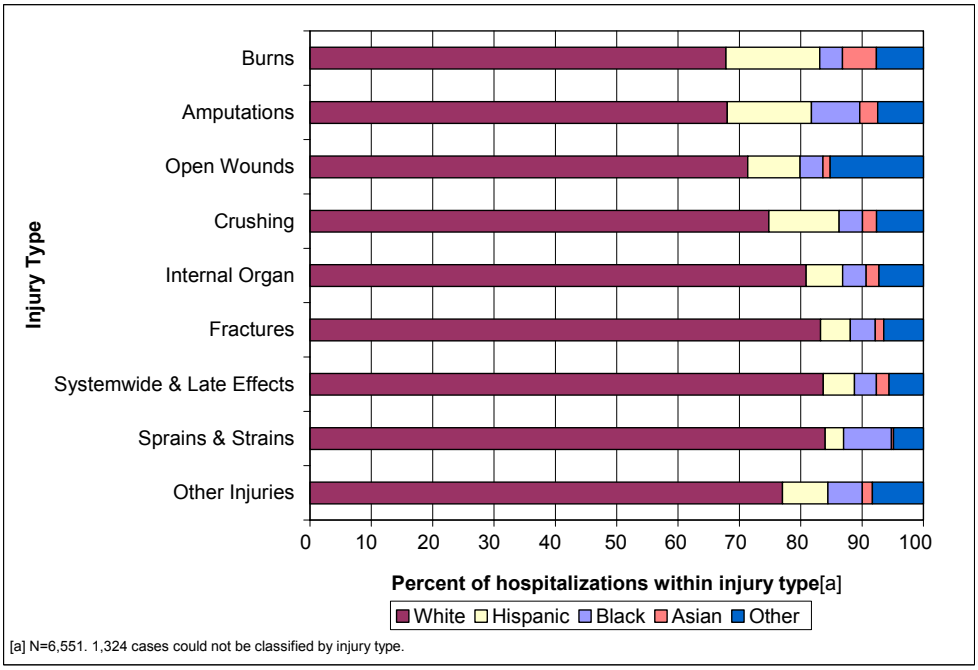


Figure 11. Percent distribution of types of work-related injuries and poisonings treated during inpatient stays, by patient age range, 1996-2000, n=6,551[a]



[a] N=6,551. 1,324 cases could not be classified by injury type.

Figure 12. Percent distribution of patient race and ethnicity by types of work-related injuries and poisonings treated during inpatient stays, 1996-2000, n=6,551



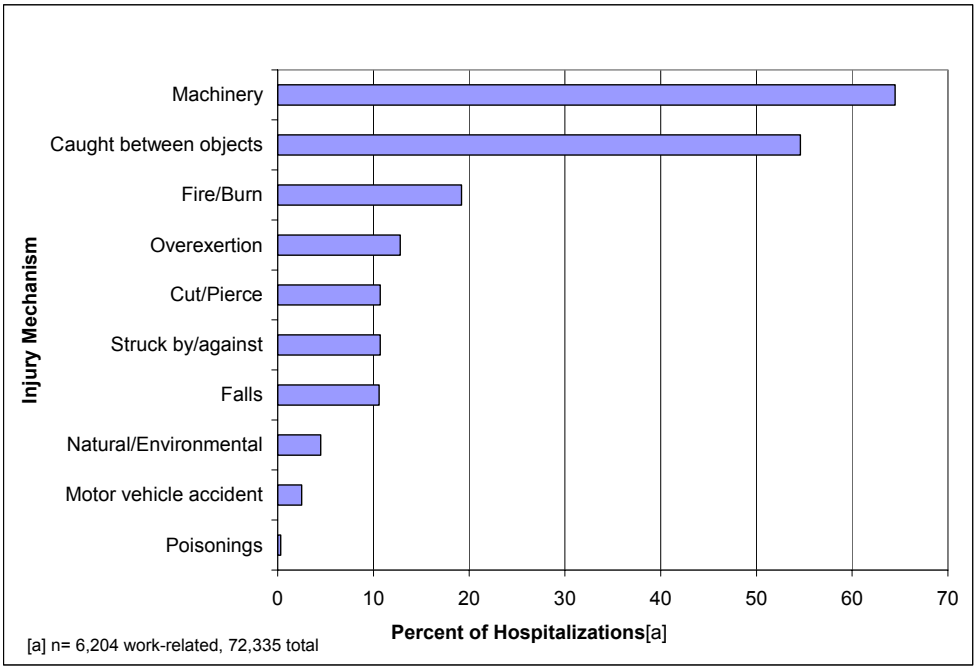
[a] N=6,551. 1,324 cases could not be classified by injury type.

Table 13 External causes of injury for work-related injuries and poisonings requiring inpatient hospital treatment, MA, 1996-2000[a]

	Number	Percentage
Falls	2,657	40.9
Machinery	782	12.0
Struck by/against	531	8.2
Cut/Pierce	405	6.2
Motor vehicle accident	403	6.2
Overexertion	375	5.8
Fire/Burns	268	4.1
Caught between objects	162	2.5
Poisonings	48	0.7
Environmental causes	41	0.6
Firearms	22	0.3
Other transportation accidents	115	1.8
Other causes	362	8.1
No cause specified	328	5.0
Total	6,499	100.0

[a] An additional 1,376 injury and poisoning cases were missing external cause of injury codes. Among them were 1,324 cases that had nature of injury codes of "Certain adverse effects not elsewhere classified" (ICD-9-CM code 995) or "Complications of surgical and medical care, not elsewhere classified" (ICD-9-CM codes 996-999).

Figure 13. Inpatient stays for work-related injuries and poisonings, by mechanism of injury, as a percentage of all inpatient injuries and poisonings for working-age adults, 16-64 years old, 1996-2000, n=6,204 work-related



Hospital Charges for Inpatient Stays Involving Work-Related Injuries and Poisonings

Total hospital charges for inpatient stays involving work-related injuries and poisonings were $123 million dollars during the 5-year period (Table 10). Of the work-related injury and poisoning cases, 83.2 % (6,551 of 7,875) could be classified by nature of injury. Table 14 summarizes the hospital charges associated with the injury and poisoning cases by nature of injury category during the five-year study period. Fractures were the most costly type of injury accounting for $54.1 million in charges (43.9 % of charges for the work-related injury and poisoning cases). Although burns comprised only 5.8% of the work-related injury cases, the average hospital charge for burns was the highest at $43,176 per hospitalization. The total charges for burns were $16.4 million, 13.3% of the total.

Table 14. Estimated total hospital charges of inpatient stays for treatment of work-related injuries and poisonings, by nature of injury, MA, 1996-2000, n= 6,551

	N	Mean Charge* ($'s)	Total Charges ($'s)	%
Fractures	3,294	16,426.6	54,109,325	43.9%
Burns	379	43,176.0	16,363,700	13.3%
Internal Organ Injuries	471	21,691.7	10,216,784	8.3%
Sprain & Strains	924	7,356.2	6,797,121	5.5%
Amputations	241	21,279.3	5,128,307	4.2%
Open Wound injuries	513	8,558.8	4,390,650	3.6%
Crushing Injuries	131	11,904.4	1,559,478	1.3%
Dislocations	147	9,177.6	1,349,110	1.1%
Systemic effects	196	6,211.6	1,217,472	1.0%
Nerve injuries	67	13,351.8	894,568	0.7%
Blood vessel injuries	39	19,933.1	777,389	0.6%
Superficial/Contusion	101	5,149.5	520,100	0.4%
Unspecified	48	9,280.8	445,479	0.4%
Other/NEC	1324	14,664.8	19,416,226	15.8%
Total	7875	15,840.3	123,185,709	100.0

Hospitalizations for Work-Related Injuries Caused by Falls

Among hospitalizations for work-related injuries and poisonings, the largest proportion, 2,657 (41.5%), involved falls. The distribution of falls varied considerably by patients' age range and gender (Figure 14). Almost three-quarters (74.3%) of hospitalizations for falls involved male patients. Most (73.5%) of the fall-related hospitalizations involving men were among those age 25-54. By contrast, hospitalizations for work-related fall injuries involving female patients were among older individuals, with almost half (47.9%) age 55 years or older.

About three-fourths (74.0%) of hospitalizations for work-related falls involved fractures (Table 15). The next most common injury types were sprain and strains (11.5%) and internal organ injuries (8.5%). Hospitalized women with work-related fall injuries suffered a higher proportion of fractures (85.3%) than did men (70.1%).

The causes of fall injuries varied by patient gender. Figures 15 and 16 present a breakdown of the causes of the occupational fall-related injuries for males and females. Falls from ladders were the most common cause of work-related falls for hospitalized men (28.4% of fall-related injuries among men) whereas only 2.8% of the injured women patients fell from ladders. Falls on the same level due to slipping or tripping were the most common cause of falls for females, being the cause of 54.6% of the fall-related hospitalizations involving women patients but only 20.4% for those involving men.

Figure 14. Percent distribution of hospitalizations for work-related injuries caused by falls, by patients' age group and gender, 1996-2000, n= 2,657 (males: 1,975, females: 682)

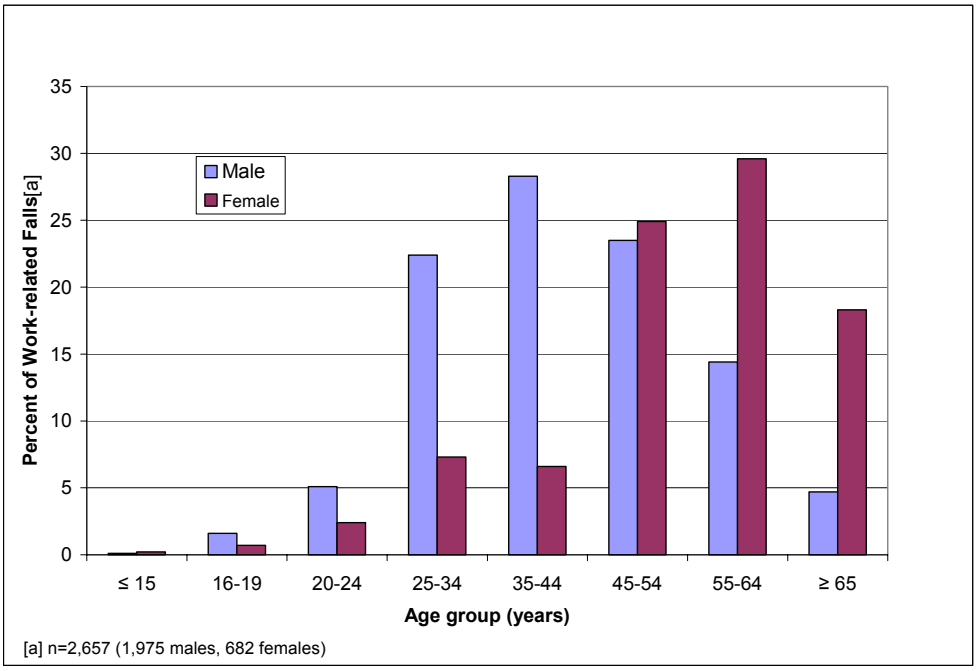


Table15. Percent distribution of hospitalizations for work-related falls by nature of injury, for males and females, MA, 1996-2000, n= 2,657

	% Male n = 1,966	% Female n = 679	% Total n = 2,645
Fractures	69.8	84.9	73.7
Dislocations	2.0	2.1	2.0
Sprain/Strains	12.4	8.5	11.4
Internal organ	10.5	2.3	8.4
Open wound	1.5	0.1	1.1
Others[a]	3.8	2.1	2.9
Total	100.0	100.0	100.0

[a] Includes12 cases for which nature of injury codes were missing

Figure 15. Percent distribution of hospitalizations for work-related fall injuries by cause of injury, for male patients, 1996-2000, n=1,975

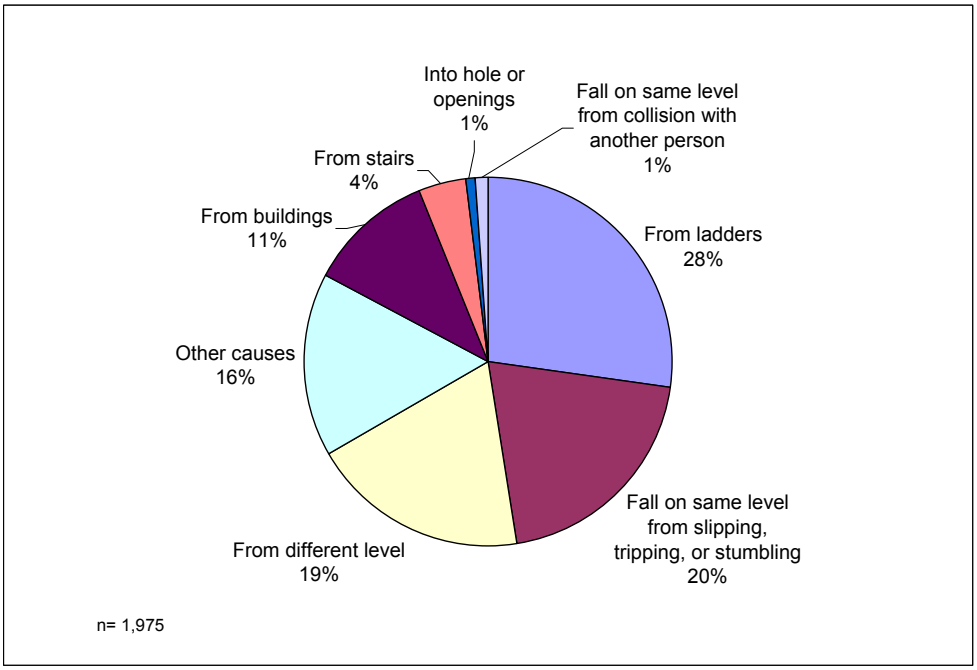
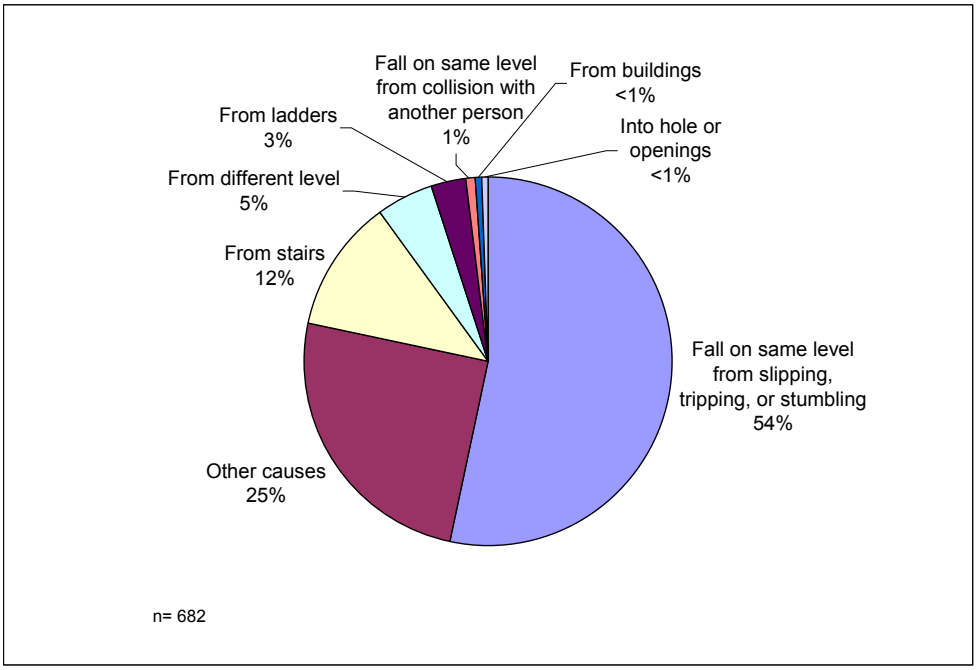


Figure 16. Percent distribution of hospitalizations for work-related fall injuries by cause of injury, for female patients, 1996-2000, n= 682



Hospitalizations for Work-Related Injuries Caused by Machinery

Among hospitalizations for work-related injuries and poisonings, 782 inpatient stays (12.2%) involved injuries caused by machinery. The vast majority of these hospitalizations (93%) involved male patients. Compared to women, proportionately more men hospitalized for machine related injuries were over the age of 44 (Figure 17).

Most of the work-related machine injuries were fractures (45%), amputations (21%), open wounds (12%), and crushing injuries (10%) (Figure 18). Among the work-related machine injuries, 70% involved the patients' upper extremities and 19% involved the patients' lower extremities.

Many varieties of machines and production activities were involved in the machine-related injuries, making it difficult to categorize the cause of these injuries precisely (Table 16). The most common causes of work-related machine injuries included lifting machines and associated equipment, such as hoists and cranes, and production operations involving woodworking and metalworking machinery.

Figure 17. Percent distribution of hospitalized patients receiving treatment for work-related injuries caused by machinery, by age group and gender, MA, 1996-2000, n= 782 (males: 727, females: 55)

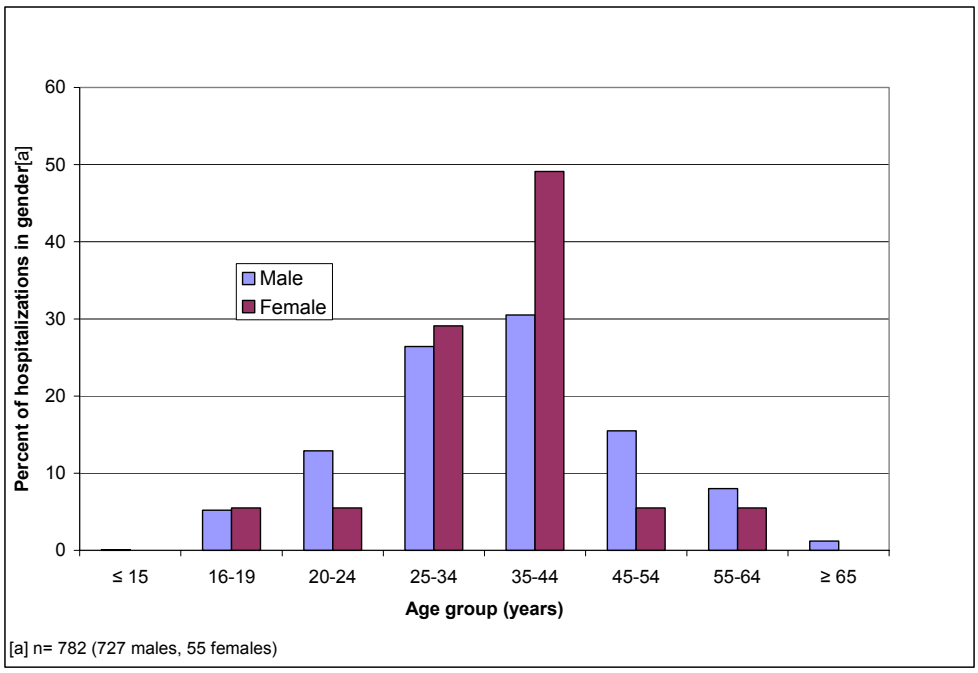
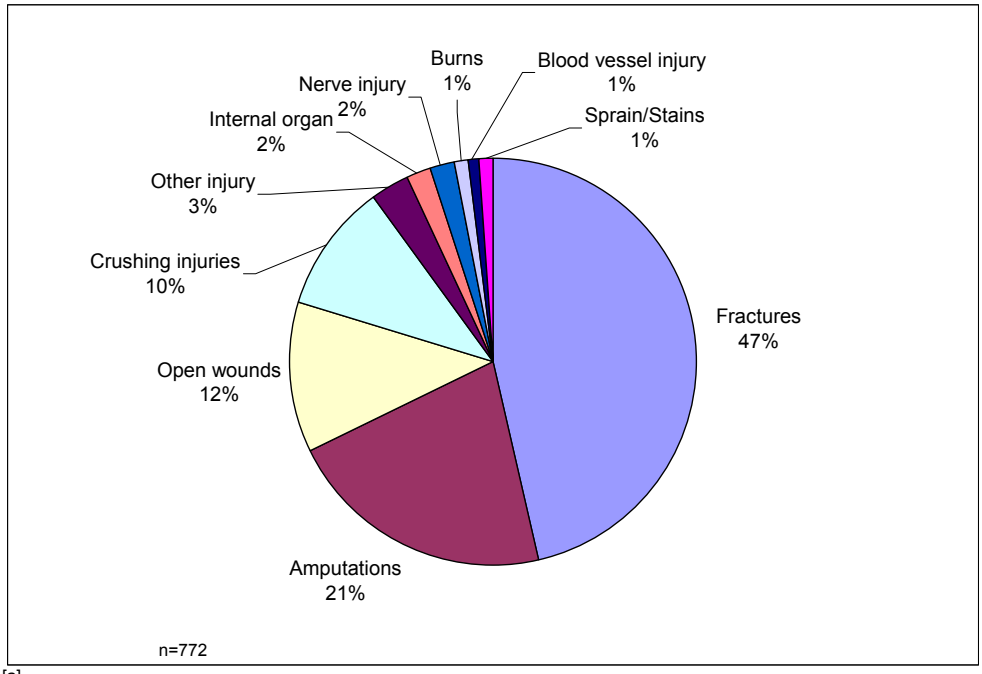


Figure 18. Percent distribution of hospitalizations for work-related injuries resulting from machinery, by nature of injury, MA, 1996-2000, n= 772[a]



[a] 10 machine-related cases had nature of injury codes that could not be classified into one of these categories.

Table 16. Causes of work-related machine injuries among hospitalized patients, MA, 1996-2000, n= 782

Machine or Activity	Frequency	Percent
Lifting equipment	141	18.0
Woodworking machine	95	12.2
Metalworking machine	56	7.2
Power transmission components	35	4.5
Earth moving, excavating	35	4.5
Agricultural machinery	12	1.5
Mining/earth drilling machinery	2	0.3
Prime mover	2	0.3
Other specific machine or activity	348	44.5
Unspecified	56	7.2
Total	782	100.0

Hospitalizations for Work-Related Injuries Caused by Burns

There were 379 hospitalizations for treatment of work-related burns. The vast majority of them (90.8%) involved male patients, and most patients (60.7%) were between 25 and 44 years of age. Table17 presents a breakdown of the causes of the work-related burn injuries. Burns due to contact with hot water or other hot substance accounted for 41% of work-related burns. The next most common cause of work-related burns was electrical contact (15.4%), followed by fire, explosion, and contact with corrosive substances.

Figure 19. Percent distribution of hospitalized patients receiving treatment for work-related injuries caused by burns, by age range and gender, MA, 1996-2000, n= 379 (males: 344, females: 35)

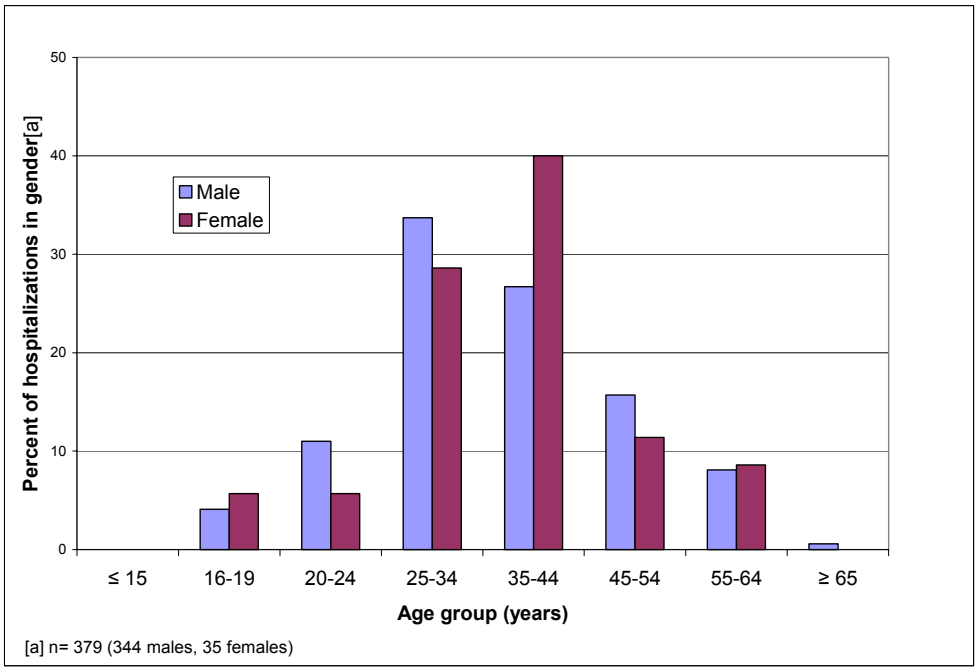


Table 17. Causes of work-related burn injuries among hospitalized patients, MA, 1996-2000, n= 370[a]

Burn causes	Frequency	Percent
Hot water or other hot substance	153	41.3
Boiling water, liquid & steam	95	25.7
Hot tap water	21	5.7
Other hot substance	37	10.0
Electrical Contact	57	15.4
Wiring and electric machine	26	7.0
Other electric burn	31	8.4
Fire and flame	47	12.7
Explosive materials or explosion	47	12.7
Caustic & corrosive substance	43	11.6
Machinery accident	12	3.2
Others	11	3.0
Total	370	100.0

[a] 9 burn-related cases were missing cause of injury codes

Hospitalizations for Treatment of Work-Related Disorders of the Musculoskeletal System and Connective Tissue

The largest category of inpatient stays for work-related conditions involved treatment for disorders of the musculoskeletal system and connective tissue (ICD-9-CM codes 710-739). There were 8,699 hospitalizations for these conditions in Massachusetts during 1996-2000, representing 42.5% of all inpatient stays for work-related conditions. The average hospital charge for inpatient care of these disorders was $11,292, resulting in a total estimated charge of $98.2 million over the five-year period.

Approximately 73.3% of patients with these conditions were male. Figure 20 summarizes the patients' age distribution for hospitalizations involving work-related disorders of the musculoskeletal system and connective tissue. Most patients (62.6%) are between the ages of 35 and 54 years old. Among hospitalized patients with work-related musculoskeletal and connective tissue disorders 86.2% were white, 4.0% black, 3.6% Hispanic, 1.4% other race/ethnicity, and for 4.8% of patients' race/ethnicity was not recorded.

This diagnostic grouping includes four subcategories: arthropathies (ICD-9-CM codes 710-719), dorsopathies (ICD-9-CM codes 720-724), rheumatism (ICD-9-CM codes 725-729), and osteopathies, chondropathies, and acquired musculoskeletal deformities (ICD-9-CM codes 730-739). A description of the specific diagnostic classifications included in each of these four subcategories is provided in Appendix B. The ICD-9-CM diagnostic grouping of disorders of the musculoskeletal system and connective tissue does not include acute musculoskeletal injuries that are categorized in the ICD-9-CM injury and poisoning grouping.

Arthropathies include most joint disorders, such as osteoarthritis and degenerative arthritis, but do not include disorders of the spine. They also include diffuse connective tissue diseases.
Dorsopathies include all back problems including intervertebral disc disorders and other cervical or back conditions.
Rheumatisms are disorders of muscles and tendons and their attachment, and of other soft tissues.
Osteopathies include disorders of bones and cartilages such as osteomyelitis and chondritis and acquired musculoskeletal deformities.

The distribution of inpatient stays for work-related conditions among these four sub-classifications is portrayed in Figure 21. The majority (61%) were dorsopathies. Among the dorsopathies, 81% involved intervertebral disc conditions (Figure 22). Approximately 79.6% of intervertebral disc conditions were lumbar disc disorders, followed by cervical disc (19.6%) and thoracic disc disorders (0.5%). Over four-fifths (82.7%) of work-related intervertebral disc disorders involved displacement of a disc without myelopathy (spinal cord disorders). Lumbar disc conditions were the primary diagnoses in 39% of all hospitalizations for work-related disorders of the musculoskeletal system and connective tissue.

Table 18 compares characteristics of inpatient care for work-related musculoskeletal conditions (paid by workers' compensation) to inpatient care for non-work-related musculoskeletal conditions (paid by a source other than workers' compensation). For this comparison, we used only cases where the patient was a working-age adult, 16-64 years old. Overall, hospitalized patients with work-related musculoskeletal disorders tended to be slightly younger (mean age 42.0 vs. 45.9), have lower mean hospital charges ($11,220 vs. $13,832) and a shorter mean length of stay (2.6 vs. 3.6 days) than patients hospitalized for musculoskeletal disorders paid by sources other than workers' compensation. Lower hospital charges and shorter length of stay for the WC cases characterized the arthropathy, rheumatism, and osteopathy subcategories. However, for dorsopathies, the predominant type of work-related musculoskeletal disorders, mean hospital charges and lengths of stay in work-related and non-work-related hospitalizations were nearly identical.

Figure 20. Age distribution of patients receiving inpatient care for work-related disorders of the musculoskeletal system and connective tissue, MA, 1996-2000, n= 8,699

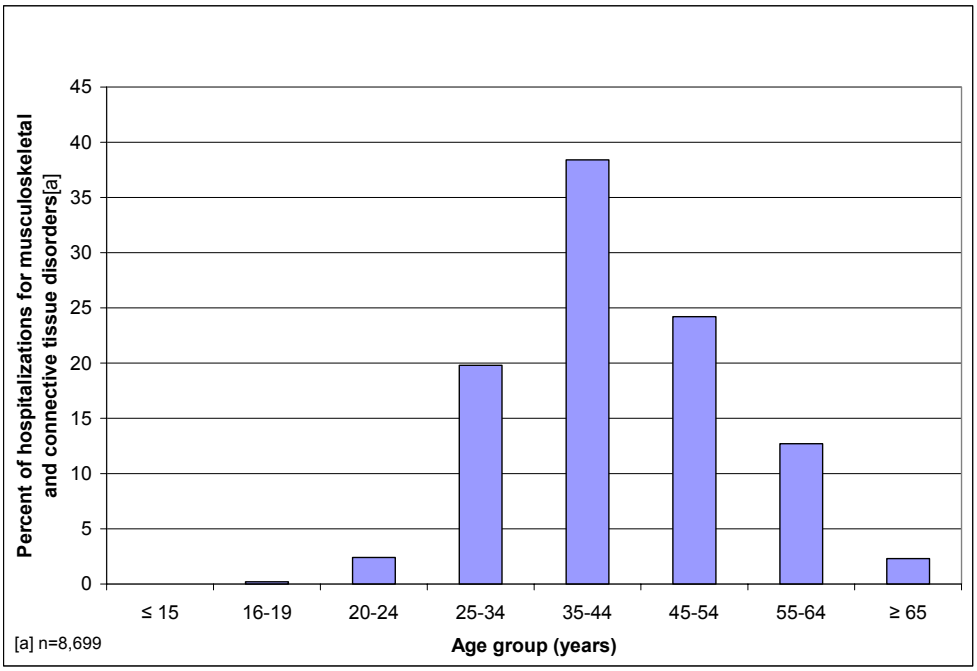


Figure 21. Inpatient stays for work-related disorders of the musculoskeletal system and connective tissue, by diagnostic subclassification, MA, 1996-2000, n= 8,699

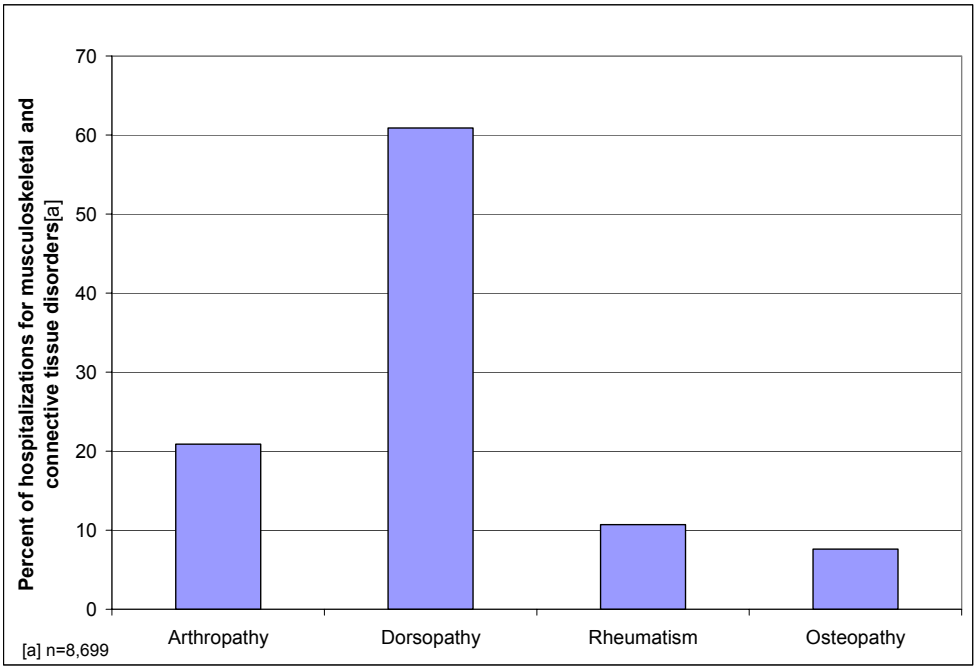


Figure 22. Types of work-related dorsopathies among patients hospitalized for care of work-related conditions, MA, 1996-2000, n= 5,296

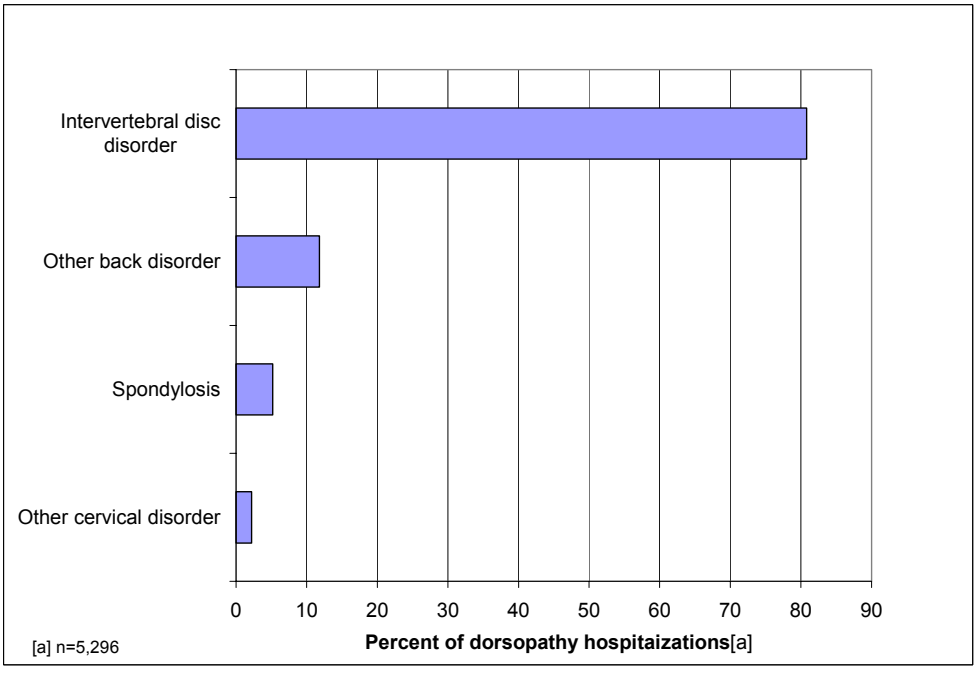


Table 18. Inpatient care characteristics for work-related musculoskeletal compared to non-work-related musculoskeletal conditions among working-age adults, 16-64 years old, MA, 1996-2000, n= 8,498 WC, n= 69,555 non-WC

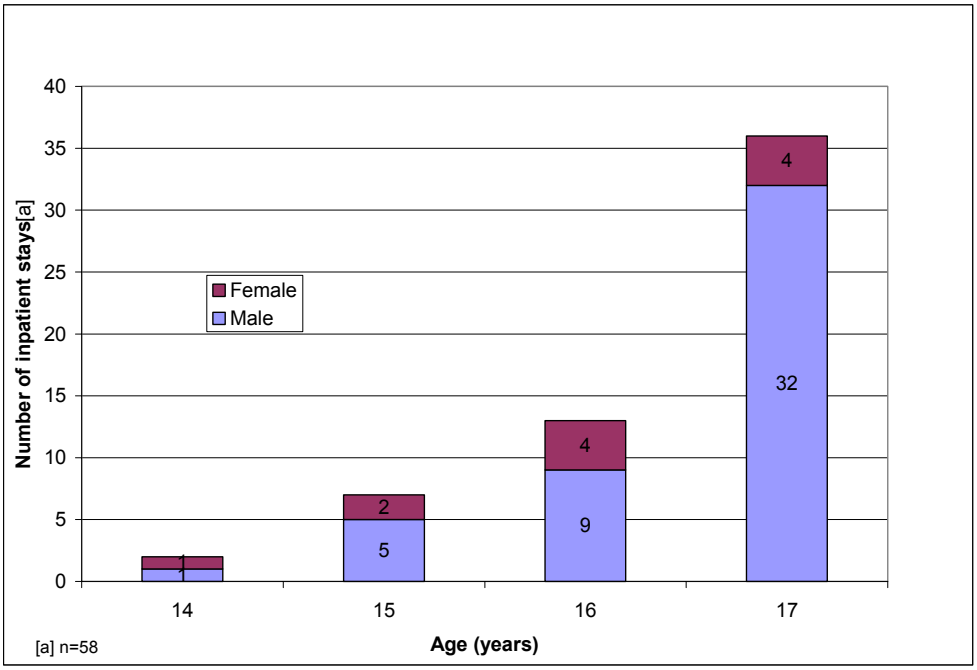
	Arthropathy		Dorsopathy		Rheumatism		Osteopathy		All Musculoskeletal	
	WC	Not-WC	WC	Not-WC	WC	Not-WC	WC	Not-WC	WC	Not-WC
Number	1,734	24,094	5,227	29,131	901	6,127	636	10,203	8,498	69,555
Mean Age (years)	42.0	48.0	41.5	44.7	45.9	45.9	41.5	44.1	42.0	45.9
Percent male (%)	75.1	46.1	72.8	51.9	71.4	53.6	76.6	52.5	73.4	50.1
Mean hospital charge ($'s)	11,843	16,620	11,041	10,848	7,394	9,842	16,418	18,162	11,220	13,832
Mean length of stay (days)	2.6	4.0	2.5	2.6	2.0	3.5	3.9	5.5	2.6	3.6

Hospitalizations for Treatment of Work-Related Disorders among Teenage Youth

Owing to the special hazards facing teenage workers, the Massachusetts Department of Public Health conducts surveillance of work-related injuries to working youths and promotes educational programs to increase awareness of occupational hazards and prevention strategies for workers younger than 18 years old. Between 1996 and 2000, there were 58 hospitalizations in Massachusetts for treatment of work-related injuries and illnesses involving patients 14-17 years old. Most of these patients (81%) were male. The majority (62.1%) of the teens receiving inpatient care for work-related conditions were 17 years old, 22.4% were 16 years old, 12.1% were 15 years old, and 3.4% were 14 years old (Figure 23). There were no hospitalizations that could be reliably identified as work-related involving patients under 14 years old.

Almost half (46%) of the work-related disorders experienced by the hospitalized teens were fractures (Figure 24) (primary diagnosis only). Other common types of work-related conditions among this group were open wounds (14%), burns (10%), crushing injuries (10%), and infectious conditions (10%). Two of the crushing injuries resulted in amputation. Among injuries having external cause of injury coding (46 of the 58 cases), the most frequent causes of injury among the hospitalized youth were falls (22%), cuts (15%), and motor vehicle accidents[4] (13%) (Figure 25).

Figure 23. Percent distribution of inpatient hospital stays for treatment of work-related disorders among teens, by age and gender, MA, 1996-2000, n= 58



[4] Under state child labor laws, teens cannot operate a motor vehicle for work; it is not known, however, if these hospitalized teens were vehicle operators or occupants.

Figure 24. Types of injuries among youths age 14-17 hospitalized for treatment of work-related disorders, MA, 1996-2000, n= 58

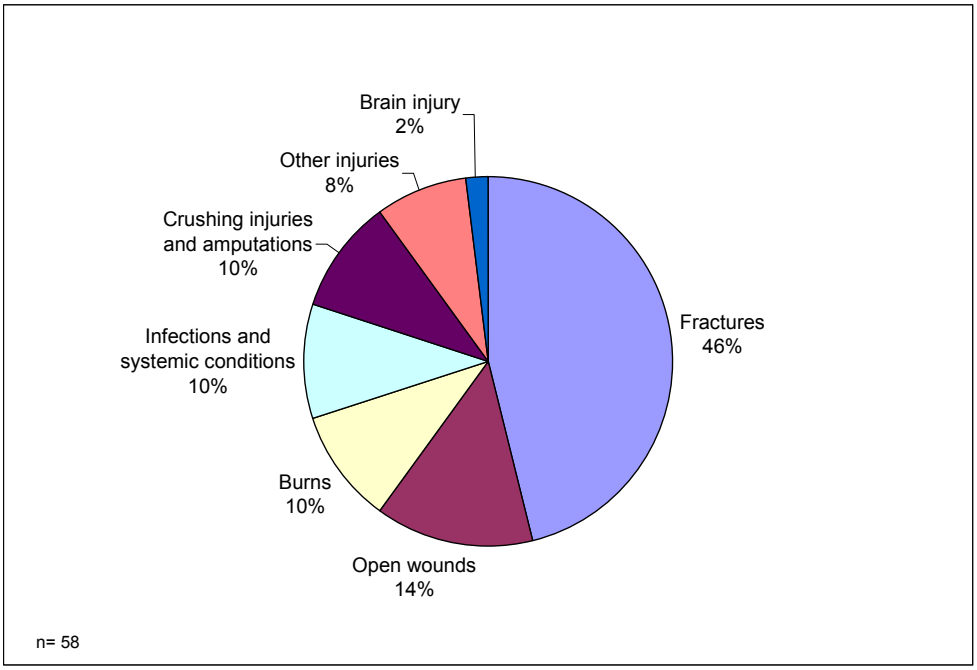
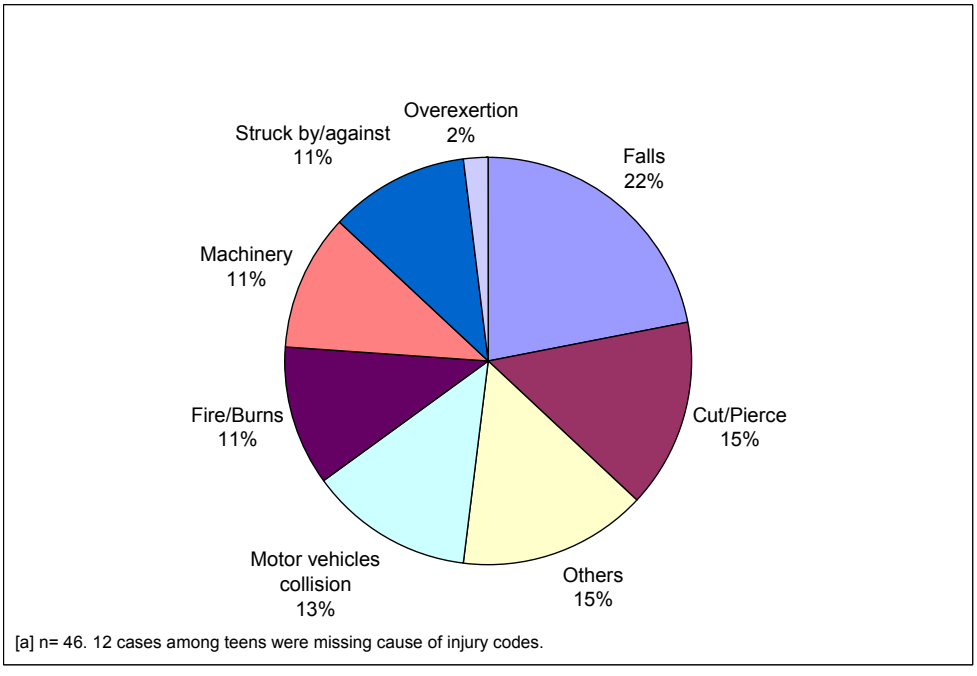


Figure 25. Causes of injuries among youths age 14-17 hospitalized for treatment of work-related disorders, MA, 1996-2000, n= 46[a]



Probable Work-Related Diseases Not Paid for by Workers' Compensation

In this study, expected payment by workers' compensation insurance was used as a marker for identifying hospitalizations for work-related conditions. However, considerable evidence suggests that there are many cases of legitimate work-induced occupational diseases that are not compensated by workers' compensation insurance for a variety of reasons including the failure to file workers' compensation claims by patients and employers, inappropriate denials of claims by insurance carriers, patients' inability to recognize their conditions as work-related, possibly owing to long latency periods prior to onset, clinicians' failure to properly investigate and diagnose the cause of the condition, and other reasons.

There are some illnesses, such as asbestosis, mesothelioma, and various kinds of chemical toxicity, that can be presumed, or at least suspected, to be work-related because of the high likelihood for the requisite precipitating exposure to be located in the patient's working environment.

Hospitalizations for patients with these illnesses were identified for all payers (WC and other sources) in an attempt to uncover additional inpatient stays for probable work-related conditions not identified previously. Both primary and any secondary diagnostic codes were included in this portion of the investigation.

Pneumoconiosis and Asbestosis

There were 127 inpatient stays with a primary diagnosis of pneumoconiosis, including asbestosis and silicosis, during the 5-year period, none of which had workers' compensation listed as the expected primary payer. It is highly probable that these cases represent work-related conditions.

In addition to a primary diagnosis, each hospital discharge record also had up to 14 secondary diagnoses listed. There were 3,798 hospitalizations that had some type of pneumoconiosis listed as either a primary diagnosis or one of the associated secondary diagnoses. (Table 19). Of those cases, only 22 (0.6%) had workers' compensation as the primary expected payer. There were 3,344 cases listing asbestosis as either a primary or secondary diagnosis.

Table 19. Pneumoconiosis, asbestosis and pneumoconiosis related inpatient hospitalizations in MA, by workers' compensation (WC) payment, 1996-2000

	Primary diagnosis (none WC)	Primary or any secondary diagnosis		
		WC	Non-WC	Total
Coalworker's pneumoconiosis	23	1	189	190
Asbestosis	76	15	3,329	3,344
Pneumoconiosis due to silica	21	2	151	153
Pneumoconiosis due to other inorganic dust	3	4	61	65
Pneumopathy due to other dust	2	0	20	20
Pneumoconiosis, unspecified	2	0	26	26
Total	127	22	3,776	3,798

Lung Cancer with Asbestosis

Exposure to asbestos is a well-known cause of mesothelioma, lung cancer, and asbestosis. Table 20 shows the number of inpatient hospitalizations for patients with lung or pleural cancer as a primary diagnosis and asbestosis as a secondary associated diagnosis. Many of these 93 cases may be related to occupational asbestos exposure. Among the 14 cases of pleural cancer, some are likely to be mesotheliomas, which are most frequently caused by occupational exposure to asbestos. Pleural cancer is only a limited indicator for mesothelioma, which is defined by histology rather than primary site. There is no specific code for mesothelioma in ICD-9CM.[xxi] [5].

[5] There were over 400 incident cases of mesothelioma reported to the Massachusetts Cancer Registry during the study period.

Table 20. Hospital inpatient stays for patients with a primary diagnosis of lung cancer and a secondary diagnosis of asbestosis in MA, 1996-2000

Diagnosis	Frequency
Bronchial cancer	6
Upper lobe lung cancer	24
Middle lobe lung cancer	2
Lower lobe lung cancer	28
Other part lung cancer	13
Unspecified lung cancer	6
Parietal pleural cancer	1
Visceral pleural cancer	1
Other pleural cancer	8
Unspecified pleural cancer	4
Total	93

Allergic Alveolitis and Pneumonitis

Among patients of working age, cases of allergic alveolitis and hypersensitivity pneumonitis often are work-related. Table 21 summarizes 64 inpatient hospitalizations for working-age (16-64 years old) patients with these diagnoses. Of the 64, only one hospitalization listed workers' compensation as the expected primary payer.

Table 21. Hospital inpatient stays for patients with a primary diagnosis of allergic aveolitis and pneumonitis, by age group and workers' compensation payment, MA, 1996-2000

	All Ages		Working Age (16-64 years)	
Primary Diagnosis	WC	Non-WC	WC	Non-WC
Bird fancier's lung	0	5	0	3
Ventilation pneumonitis	0	1	0	0
Allergic alveolitis and pneumonitis[a]	0	23	0	14
Unspecified allergic alveolitis and pneumonitis	1	84	1	46
Total	1	113	1	63

[a] Includes cheese-washers' lung, coffee workers' lung, fish-meal workers' lung, furriers' lung, grain-handlers' disease or lung, pituitary snuff-takers' disease, sequoiosis or red-cedar asthma, and wood asthma.

Chemical Related Diseases

ICD-9-CM provides diagnostic codes for toxic effects resulting from chemical exposure (codes 980-989). Some of these chemicals or substances are commonly used in occupational environments, so toxic effects related to these exposures potentially may be work-related. Table 22 lists many of the chemicals and substances that are most likely to be related to patients' working environments. Cases of intentional poisoning have been excluded from this table. Between 1996 and 2000, there were 637 inpatient stays in Massachusetts resulting from unintentional exposure to these substances, 313 of which were among working age (16-64) patients. Only 38 of these cases (12.1%) had workers' compensation indicated as the expected primary payer.

Table 22. Inpatient hospital stays related to toxic effects from unintentional exposure to selected chemicals and substances, by age group and workers' compensation payment, MA, 1996-2000

Description	All Ages		Working ages (16-64 years)	
	WC	Non WC	WC	Non WC
Methyl alcohol	0	7	0	4
Isopropyl alcohol	0	29	0	26
Other specified alcohol	0	4	0	4
Unspecified alcohol	0	13	0	10
Benzene, gasoline, kerosene, paraffin wax, ether, naphtha, spirit	0	12	0	0
Acetone	1	12	1	8
Carbolic acid or phenol, Cresol	1	3	1	2
Acid: hydrochloric, nitric, sulfuric	1	15	1	14
Alkalis: Lye, potassium hydroxide, sodium hydroxide	3	29	3	4
Caustic, unspecified	2	22	2	5
Inorganic lead compounds: lead dioxide, lead salt	0	83	0	2
Organic lead: lead acetate, tetracetyl lead	0	1	0	0
Other lead compound	0	10	0	2
Unspecified lead compound	0	18	0	1
Mercury	0	2	0	1
Arsenic	0	2	0	2
Other metal: Brass fumes, copper salts, iron compounds, nickel	0	19	0	14
Carbon monoxide	6	84	6	44
Liquefied petroleum gas: butane, propane	0	5	0	0
Other hydrocarbon gas	2	5	2	0
Sulfur dioxide	0	1	0	1
Chlorine gas	3	4	3	2
Hydrocyanic acid gas	2	0	2	0
Phosgene, polyester fumes	3	28	3	21
Unspecified gas, fume, or vapor	13	173	13	98
Cyanide: potassium cyanide, sodium cyanide	1	1	1	0
Chlorinated hydrocarbons; Aldrin, Chlordane, DDT, Dieldrin	0	2	0	2
Organophosphate and carbamate	0	2	0	2
Other pesticides, not elsewhere classified	0	13	0	6
Total	38	599	38	275

Conclusions

In this study, hospital discharge records from the HDD database were used to develop basic descriptive information about inpatient stays for treatment of work-related conditions paid for by workers' compensation insurance at Massachusetts hospitals from 1996 to 2000. There were 20,457 inpatient stays for work-related conditions, accounting for 0.56% of the over 3.6 million hospital admissions in the state during that five-year period, and approximately 1.2% of hospitalizations involving working-age adults (16-64 years old). Combining these findings with information about reported workplace illnesses and injuries from the U.S. Bureau of Labor Statistics' Survey of Occupational Injuries and Illnesses suggests that about 3.2% of all occupational injuries and illnesses in Massachusetts resulted in hospital admissions. This is similar to findings from national studies of work-related injuries and illnesses and hospitalization[xxii]. The rate of admissions for treatment of work-related conditions was 125.9 per 100,000 Massachusetts workers.

The vast majority of inpatient stays for work-related conditions were for treatment of musculoskeletal disorders and acute injuries. Most of the hospitalized patients were males between the ages of 25 and 54. The average length of an inpatient stay for a work-related condition was 3.6 days. The mean hospital charge per case was $13,023. Total charges for inpatient care of work-related conditions in Massachusetts amounted to $266 million from 1996 to 2000. Descriptive statistical information was compiled for specific types of injuries including those caused by falls, machinery, and burns.

This exploratory examination of hospital discharge data has demonstrated that the data provide a means to identify the most serious type of occupational injuries and illnesses and are useful in describing the incidence, nature, severity, and causes of serious work-related conditions in Massachusetts. The information obtainable from hospital discharge data can be used to supplement information obtainable from other data sources such as workers' compensation claims records, workplace illness and injury logs, population-based surveys, and emergency room records.

The analyses have demonstrated several advantages of using hospital discharge data for occupational surveillance purposes:

- The dataset contains a wide assortment of clinical information concerning diagnosis, medical services provided, the nature and cause of injuries, and patient characteristics
- The discharge data are collected annually for administrative purposes and thus are readily available at no additional cost for use in occupational health surveillance,
- Information is relatively complete and covers all acute care hospital inpatient stays occurring in the state,
- These data are useful in resource and financial planning for medical treatment of occupational injuries and illnesses,
- In some cases, discharge records can provide an indication of the incidence of some work-related illnesses (e.g., asbestosis and toxic chemical exposure) that

may not be available from workers' compensation or other conventional occupational disease surveillance methods, and
- The collection of discharge data on an annual basis potentially allows for the assessment of trends over time in the incidence and treatment of various work-related conditions.

The availability of "E-codes" that provide information about the external causes of injuries has been particularly useful in this study in that it has allowed us to gain insight about the activities which caused serious occupational injuries, a key component in devising effective prevention strategies.

An important advantage of hospital discharge data for occupational health surveillance, compared to other available data sources, is that it captures information about all injuries, work-related and non-work-related, allowing an assessment of the contribution of work-related injuries to the overall injury burden, fostering integrated approaches to prevention that cross public health disciplines (e.g. injury control and occupational health).

The study also highlighted many of the obstacles involved in using hospital discharge data for occupational health surveillance. Most notably, the work-relatedness of conditions can only be inferred indirectly by looking at cases that are expected to be paid by workers' compensation insurance. There is no method currently available for recording independent clinical or patient-provided information about the work-relatedness of the disorder being treated. Since many cases of work-related disorders may not be paid by workers' compensation, the hospital discharge records cannot be expected to provide a comprehensive assessment of the true extent of hospitalizations for occupational conditions.

Moreover, the discharge data do not contain information about the patients' employment, which would be important in trying to understand the causes of work-related injuries and illnesses among working adults. Likewise, information is not available about the onset of the injury or illnesses. Although hospital charges are indicated, the actual costs and payments for care often are substantially different than the initial hospital charges, and thus the ultimate financial impact of treating these conditions are difficult to estimate accurately. The process by which data was entered onto discharge records was not evaluated in this study, and thus it is not possible to be certain about its validity. The ultimate utility of using hospital discharge records for surveillance purposes will be dependent on the accuracy and reliability of the information recorded therein by the hospital's clinical and administrative staff.

The outcome of this study is sufficient to warrant continued periodic examination of HDD to supplement other occupational health surveillance activities in the state. MDPH should work with DHCFP to explore possible steps to improve the usefulness of hospital discharge data in this regard. Potential strategies for improving the utility of hospital discharge records for occupational health surveillance include:

- Explore the possibility of collecting information on injury at work similar to the information collected on death certificates. This would help capture work-related injury cases for workers not covered by workers' compensation. The possibility of collecting information on the activity at the time of injury for all injuries should also be explored. An activity code is included in ICD-10-CM and includes work as one of several options. The inclusion of activity codes would provide additional information that could be used to target intervention activities.

- The inclusion in the database of a dedicated second E-code field, which is already being submitted by some hospitals, should be explored. The second E-code provides information on the location at time of injury and could provide additional information on the circumstances of injury.

- Complete and accurate entry of E-code information should be emphasized.

Employer information (name and address) has been found to be available in computer data systems of hospitals and is important for occupational health surveillance, but the time and expense of coding this information limits its usefulness in routine surveillance. The option of collecting employer information in the HDD should be explored. At a minimum, MDPH should have legal access to this information when necessary for specific studies. Currently access to this information is at the discretion of the individual hospitals for all but specific work-related conditions that are required to be reported under public health regulations.

This report has taken a preliminary look at using the HDD data for occupational health surveillance and has found the data useful in describing the nature and extent of work-related injury and illness, even when using a limited number of coded data fields. The HDD data represents a rich data source for occupational health surveillance. Further exploration of the data is warranted in a number of areas:

- The sensitivity of using workers' compensation as expected payer as the indicator of work-relatedness needs to be determined to assess the proportion of work-related injuries and illnesses that may be missed by this type of analysis.
- The use of secondary diagnosis codes may provide a fuller characterization of illnesses and injuries.
- The possibility of linking the HDD data with workers' compensation data from the Massachusetts Department of Industrial Accidents would provide the opportunity for a much richer assessment of the employment circumstances surrounding serious injuries, patients' success in accessing timely and appropriate medical care, and identifying prevention opportunities.

These analyses may prove useful in assessing data quality for surveillance and extending the range of occupational health issues that can be addressed using these data.

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Inpatient Hospitalizations for Work-Related Injuries and Illnesses in Massachusetts, 1996-2000

Appendices

Appendix A: Readmissions Paid by Workers' Compensation

Purpose

The main body of this report documents the nature and extent of hospital admissions for work-related injuries and illnesses for the period 1996-2000. Among the 20,457 hospital admissions for work-related conditions during this period, 3,680 were repeat admissions for individual patients. While patients admitted to hospitals for inpatient care generally have more serious types of illnesses and injuries than those treated on an outpatient basis or in the emergency room only, the reasons for re-admission to the hospital may not be so easily generalized. Initial severity of the injury or illness may play some part, but many other factors also affect readmission rates. Readmission may be planned, such as occurs for rehabilitative care, planned treatments, or follow-up care; or unplanned, occurring due to disease or treatment complications or failure of treatments. Re-admission may also be for a different diagnosis unrelated to prior admission. Lingering effects of injury or illness may result in a greater tendency for re-injury, to the same or different body parts

Previous studies have examined hospital re-admissions to assess utility of medical procedures[i], quality of care across hospitals[ii] [iii], and groups subject to repeat injury (trauma recidivism)[iv]. Hospital re-admissions have also been identified as a complication to assessing true occupational injury rates[v] [vi]. In this appendix, the Massachusetts Hospital Discharge Database (HDD) for 1996 to 2000 is examined to characterize the nature and extent of hospital re-admissions for work related conditions. This analysis is simply descriptive. The range of conditions for which these re-admissions are reported precludes ascribing cause and effect to the rates for any particular health condition or hospital. Examination of the extent of re-admission may provide a better picture of the true incidence of work-related injuries and illnesses serious enough to result in hospitalization. Further, it may give a better indication of the financial cost and human burden of individual workplace injury or illness incidents.

Methods

A hospital discharge record is classified as work-related if the primary expected payer listed in the record is Workers Compensation (WC). (See methods in main report). The total number of work related hospital discharge records was 20,457 during the period 1996 to 2000. Sixty-seven of these admissions appeared to be duplicates, having the same admission date as another record for a uniquely identified subject (See below). Some of these apparent duplicates may occur as legitimate admissions where a patient is admitted to one hospital and then transferred to another the same day. These legitimate admissions cannot be distinguished from actual duplicates in this database and these records were retained in the counts for all work-related admissions. They were removed from the database for analysis of readmissions, since, in the analysis of time between

admissions, they resulted in negative values for days between admissions (see below). The resulting data base of work-related admissions for this analysis contained 20,390 total admissions.

To identify repeat hospital admissions, the encrypted social security number (ESSN) and date of birth were used as personal identifiers, rather than medical record number (MRN). Subjects can be admitted to different hospitals and be assigned different MRNs or can be assigned different MRNs when re-admitted to the same hospital. The ESSN was missing for 1,688 records. In these cases, MRN and date of birth were used as the personal identifier instead of the encrypted social security number. Records without ESSN were matched back to records with ESSN on MRN and date of birth to check for readmissions for which SSN had not been recorded. Matching records were assigned the existing ESSN. Records without ESSN also were checked against each other for readmissions on MRN and date of birth.

Readmission was defined as the second and all later admissions. The total number of readmissions was 3,680. The period between the admissions was calculated as the period between the prior discharge date and the subsequent admission date. Hospital charges were total hospital charges as recorded in the discharge record. The hospital charges recorded in the discharge record do not reflect possible discounts that are applied nor do they reflect charges from individual care givers, however, they provide an index of the cost of the hospital admission (See Limitations in main body of report). The length of stay was calculated as the difference in days between the admission date and the discharge date.

Extent of Repeat Admissions

The 20, 390 work-related admissions in the observation period involved 16,710 individuals. Thus, 3,680 admissions (18.0% of all work-related admissions) were for subjects who were previously admitted for work-related conditions during the period of observation. Table A-1 shows the distribution of subjects by the number of admissions. Among all work-related admissions, 70% (14,353/20390) were for injuries or illness that resulted in single admissions only, accounting for the same number of subjects (85.9% of all subjects). The remaining 2,357 (14.1%) subjects accounted for 30% of work-related hospital admissions. The subjects admitted most frequently were admitted 22 times during the period of observation. Table A-2 shows the distribution of work-related admissions by admission sequence.

Table A-1. Number of subjects by number of work-related hospital admissions, MA, 1996-2000

No. of admissions	No. of Workers	Percent
1	14,353	85.9
2	1,722	10.3
3-5	555	3.3
6-10	64	0.4
11+	16	0.1
Total	16,710	100.0

Table A-2. Number of work-related admissions by admission sequence, MA, 1996-2000

Admission Sequence	No. of Admissions	Percent
1st	16,710	82.0
2nd	2,357	11.6
3rd – 5th	1,057	5.2
6th –10th	197	1.0
11th+	69	0.3
Total	20,390	100.0

Table A-3 shows the distribution of subjects for all work-related admissions and work-related readmissions by age category, gender and race/ethnicity. Subjects over 35 years old and whites were more likely to be readmitted for work-related conditions. There was no appreciable difference between the proportions of admissions and readmission within genders.

Table A-3. Distribution of Subjects for All admissions and Readmissions by Age, Gender and Race/Ethnicity, MA, 1996-2000, n= 20,390

		All Admissions		Readmissions	
		Number of Workers	Percent	Number of Workers	Percent
Age					
	Less than 16	14	0.08	0	0
	16 - < 20	219	1.31	14	0.59
	20 - < 25	778	4.66	63	2.67
	25 - < 35	3448	20.63	414	17.56
	35 - <45	5315	31.81	786	33.35
	45 - <55	3894	23.3	566	24.01
	55 - <65	2368	14.17	365	15.49
	>= 65	674	4.03	149	6.32
Gender					
	Female	3716	22.24	542	23.00
	Male	12994	77.76	1815	77.00
Race					
	White	13968	83.61	2032	86.21
	Black	746	4.47	107	4.54
	Hispanic	768	4.6	85	3.61
	Asian	159	0.95	16	0.68
	Other	1066	6.38	117	4.96

Diagnostic classification of work-related readmissions

Table A-4 lists the frequencies of readmissions by Clinical Classification Software system (CCS) code for the 20 most frequent work-related readmissions and the corresponding frequencies for first admissions. The most frequent diagnosis for readmission was “spondylosis, intervertebral disc disorders” (20.7%), which was also the most frequent diagnosis for first admissions and all admissions. The second and third most frequent diagnoses for readmission are “complication of device or implant” (11.8 %) and “complication of surgical procedures or medical care” (9.8%). If these later two categories are grouped as “complications of previous treatment”, they account 21.6% of all readmissions, more than for “spondylosis, intervertebral disc disorders.” The “complications of previous

treatment" diagnoses clearly suggest a prior admission; however, 3.4 percent of first admissions have this diagnosis. Some of these diagnoses may be complications to treatments that did not require a hospital admission (e.g., outpatient or emergency department) or in hospitals outside of Massachusetts. Some of these diagnoses may appear as first admissions in the period of observation due to initial admissions prior to the time period covered by this study. The "complications of previous treatment," "rehabilitative care, fitting of prosthesis", and "chronic ulcer of the skin" occur with greater frequency as readmissions than as first admissions. Other diagnoses, including, "other bone disease and musculoskeletal deformities," "other nervous system disorders," "coronary atherosclerosis and other heart disease," "infective arthritis and osteomyelitis," "other acquired deformities," "acute myocardial infarction," "and "phlebitis, thrombophlebitis and thromboembolism" occur proportionately more frequently as readmissions than as first admissions.

Readmissions by initial diagnosis

Table A-5 shows the CCS codes of the initial diagnoses that resulted in the greatest number of second admissions. The rate of second admissions across all CCS codes is 14.1%. Some diagnostic codes (not shown) have very high readmission rates (30-100%), but very low numbers of admissions (<5). Of the initial diagnoses having the highest frequency of readmissions, "Complications of device, implant or graft" has the highest readmission rate (26.8%), followed by "other nervous system disorders" (22.6%), "Other acquired deformities" (21.6%), "Fracture of neck of femur (hip)" (21.0%), and "Osteoarthritis" (18.9%). These same diagnoses, except for "Fracture of neck of femur (hip)" also have high rates of second admissions that are for the same diagnosis or a complication diagnosis. "Spondylosis, intervertebral disc disorders" also has a high rate of second admissions for the same or a complication diagnosis and has the greatest fraction of readmissions that are for the same or a complication diagnosis (605/697, 86.8%). Overall, 57.7% of second admissions are for the same diagnosis as the first visit or a complication of care diagnosis. For these readmissions, there is a very strong likelihood that they are related to the injury or illness that resulted in the initial hospitalization.

Table A-4. Frequency of readmission for work-related hospitalizations by Clinical Classification Software (CCS) code and corresponding first admission frequency, MA, 1996-2000

	Readmissions (N=3,680)		First Admissions (n= 16,710)	
CCS code labels	Frequency	Percent	Frequency	Percent
Spondylosis, intervertebral disc disorders, other back problems	763	20.7	4,529	27.1
Complication of device, implant or graft	465	11.8	342	2.0
Complications of surgical procedures or medical care	360	9.8	238	1.4
Other connective tissue disease	139	3.8	788	4.7
Other bone disease and musculoskeletal deformities	133	3.6	193	1.2
Other nervous system disorders	113	3.1	217	1.3
Osteoarthritis	106	2.9	482	2.9
Joint disorders and dislocations, trauma-related	93	2.5	658	3.9
Fracture of lower limb	90	2.4	1440	8.6
Other non-traumatic joint disorders	86	2.3	430	2.6
Skin and subcutaneous tissue infections	83	2.3	534	3.2
Rehabilitation care, fitting of prosthesis	82	2.2	21	0.1
Coronary atherosclerosis and other heart disease	79	2.1	154	0.9
Infective arthritis and osteomyelitis	67	1.8	90	0.5
Other acquired deformities	66	1.8	176	1.1
Sprains and strains	46	1.3	877	5.2
Chronic ulcer of skin	41	1.1	31	0.2
Acute myocardial infarction	40	1.1	144	0.9
Phlebitis, thrombophlebitis and thromboembolism	39	1.1	101	0.6
Other fractures	39	1.1	391	2.3

Table A-5. Second admission rate[a] by initial admission diagnosis and second admission diagnosis category, MA, 1996-2000

Diagnosis for initial hospitalization	Initial Admission	All second admissions		Second admissions by second admission diagnosis			
	Number	Number	Rate[a]	Same[b]	Comp[c]	Same/Comp Rate[a]	Other Diagnosis
All Diagnoses	16710	2357	14.1%	950	409	8.4%	950
Spondylosis, intervertebral disc disorders	4529	697	15.4%	466	139	13.4%	92
Fracture of lower limb	1440	248	17.2%	67	47	7.9%	134
Fracture of upper limb	776	101	13.0%	22	20	5.4%	59
Osteoarthritis	482	91	18.9%	34	28	12.9%	29
Complication of device, implant or graft	342	90	26.3%	31	9	11.7%	50
Other connective tissue disease	788	76	9.6%	31	7	4.8%	38
Joint disorders and dislocations, trauma	658	74	11.2%	22	14	5.5%	38
Fracture of neck of femur (hip)	295	62	21.0%	16	9	8.5%	37
Sprains and strains	877	60	6.8%	12	15	3.1%	33
Other non-traumatic joint disorders	430	53	12.3%	10	14	5.6%	29
Open wounds of extremities	601	50	8.3%	7	11	3.0%	32
Other nervous system disorders	217	49	22.6%	32	6	17.5%	11
Burns	349	46	13.2%	20	4	6.9%	22
Intracranial injury	321	44	13.7%	4	3	2.2%	37
Skin and subcutaneous tissue infections	534	43	8.1%	18	7	4.7%	18
Complications of surgical procedures	238	39	16.4%	17	4	8.8%	18
Other acquired deformities	176	38	21.6%	4	14	10.2%	20
Other fractures	391	38	9.7%	7	6	3.3%	25
Crushing injury or internal injury	360	36	10.0%	2	5	1.9%	29

[a] Second admissions as a percentage of initial admissions.
[b] Second admissions with the same diagnosis as the initial admission.
[c] Second admissions with a complication of prior treatment diagnosis.

Timing of work-related readmissions

Table A-6 shows the distribution of the time between the discharge date of the first hospital admission and the admission date of the second admission. More than a third of the second admissions occur within one month and more than 60% occur within 6 months of the initial hospitalization.

Figure A-1 is a graph of the second admissions as a proportion of first admissions for second admissions that are for the same diagnosis, a complication of care diagnosis or a different diagnosis. The three types of readmission diagnoses show a similar pattern of decrease with time after initial first admission, with the rate dropping sharply after the first two weeks and leveling off to a constant low rate at 8 to 12 weeks. The similarity of the rates in the first months after the first admission may indicate that most of the second admissions in this period, not just those that have the same diagnosis or a complication of care diagnosis, are related to the initial injury or illness. Approximately 43% of second admissions with a different diagnosis, about 18% of all second admissions, occur within 12 weeks of the initial discharge date.

Table A-6. Time (days) between discharge date of first admission and admission date of second admission

Time between first discharge and second admission	Frequency	Percent	Cumulative Percent
< 1 months	824	35.0	35.0
2 to 3 months	287	12.2	47.2
3 to 6 months	269	11.4	58.6
6 to 12 months	425	18.0	76.6
1 to 2 years	355	15.1	91.7
> 2 years	197	8.4	100.0
Total	2,357	100.0	

Hospital charges and Length of stay

Table A-7 shows the average and median hospital charges for all admissions, first admissions only, and readmissions. Mean and median charges for readmissions are greater than the charges for first admissions.

This is likely accounted for, at least in part, by the longer lengths of stay for readmissions (Table A-8).

FigureA-1. Time lag of second admission by second admission diagnosis (same, different or complication)

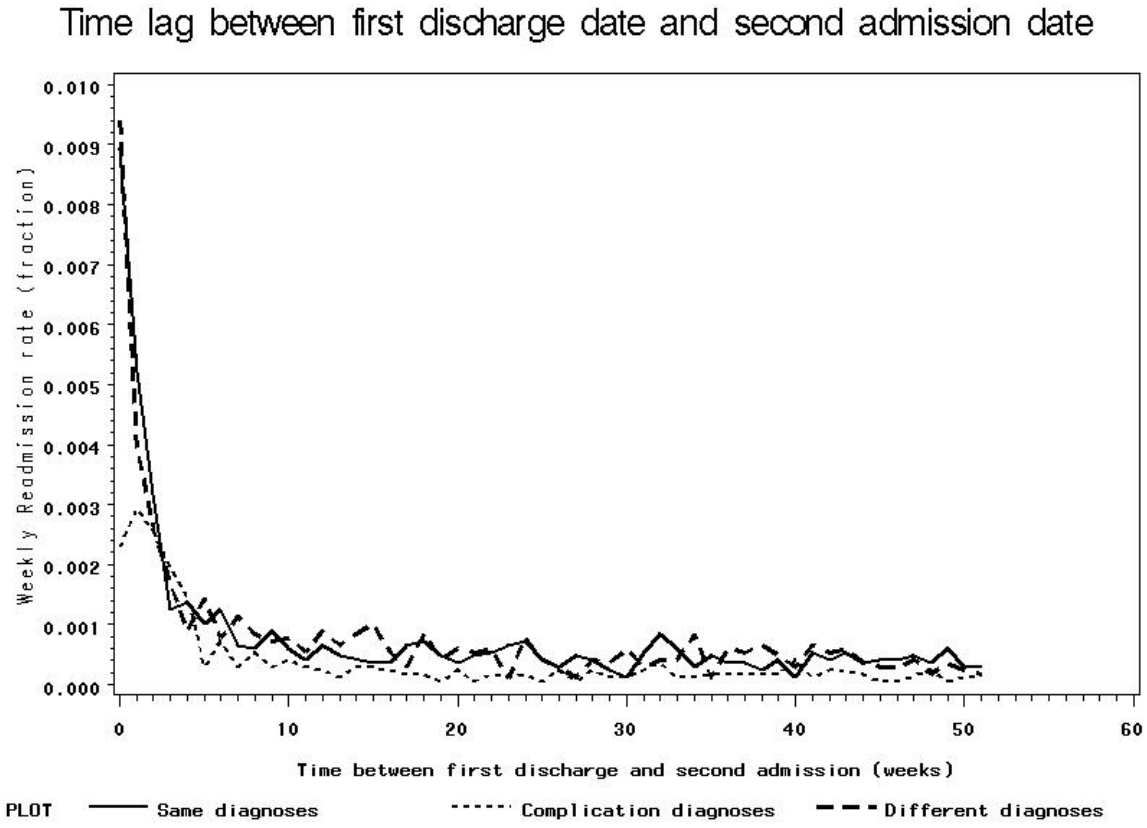

Table A-7. Mean and median hospital charges per admission for all work related admissions, first admissions and readmissions

	Mean	Median
All work-related admissions	$ 13,044	$ 8,123
First admissions	$ 12,828	$ 7,921
Readmissions	$ 14,028	$ 9,480

Table A-8. Mean, median, and 75th percentile for length of stay for all work related admissions, first admissions and readmissions

	Mean	Median	75th percentile
All work-related admissions	3.66	2	4
First admissions	3.39	2	4
Readmissions	4.83	3	6

Discussion

The foregoing analysis indicates that approximately 18% of all work-related hospital admissions are readmissions for a particular individual. The proportion of these readmissions that are related to the initial injury or illness cannot be definitively determined without a review of individual medical records. However, this analysis has found that 57.7% of second admissions are for the same diagnosis as the first visit or for a complication of care diagnosis and are very likely related to the injury or illness that resulted in the initial hospitalization. Among the second admissions with different diagnoses from the first admission, 43% occurred within a timeframe similar to the same and complication diagnoses, indicating a strong likelihood that these, 18.2% of all second admissions, are also related to the injury or illness that resulted in the initial hospitalization. Together these estimates indicate that about 60 to 75% of work-related second admissions are related to the initial hospitalization and, consequently, 25 to 40% of readmissions are actually first admissions for a condition unrelated to the previous hospitalization and indicate a new work-related condition.

There are a number of uncertainties in this estimate. First, using diagnostic codes to define the association between separate admissions provides only a probability of there being an association in any particular case. Two admissions for the same person with the same diagnostic code could result from two different incidents. As stated above, only a review of individual medical records could determine the relationship with certainty. Second, only primary diagnosis codes were used to determine any association between first and second admissions. Linking primary, secondary and subsequent diagnostic codes may uncover additional related admissions and readmissions. Only second admissions were examined for related readmissions. Examining third and subsequent admissions could also uncover additional related admissions and readmissions; however, it is unclear how this additional analysis would affect the proportion of readmissions relative to first admissions. Taking these uncertainties into account, we can estimate that at least 60% of work-related readmissions are related to the initial hospitalization.

The readmission rates estimated in this analysis have a number of implications for use of hospital discharge data for occupational health surveillance. First, where work-related hospital admissions are used as a surrogate for serious, non-fatal work-related injuries and illnesses, the raw number of work-related hospital admissions overestimates the number of injuries and illnesses. In the main body of this report the average hospitalization rate for work-related conditions as a proportion of the state labor force is estimated as 138.6 admissions per 100,000 workers. Using first admissions only as a surrogate for serious, non-fatal, work-related injuries and illness yields an estimate of 113.2 admissions for work-related conditions per 100,000 workers. Taking into consideration the above estimate that 25 to 40% of apparent readmissions may indicate a new work-related condition, an estimate of 119.6 to 123.4 admissions for work-related conditions per 100,000 workers is obtained. Likewise, the main report estimates 3.2% of all work-related injuries and illnesses result in hospital admissions based

on occupational injury and illness incidence estimates from the United States Bureau of Labor Statistics. When adjusted for all readmissions, the rate is 2.6%; when adjusted for 60 to 75% of readmissions related to the first admission, the rate is 2.7 to 2.8%.

Conversely, the raw hospital admission rate underestimates the financial impact of individual injuries. Injuries or illnesses that result in more readmissions have a greater financial impact. The average total hospital charge for an inpatient stay for treatment of a work-related condition was $13,022. If we consider all readmissions as being related to the initial diagnosis, the estimated average cost per injury or illness is $15,942. If only second admissions are considered as being related to the initial diagnosis, the estimated average cost per injury or illness is $14,859. If 60% of readmissions are considered related to the initial diagnosis, the estimated average cost per injury or illness is $15,070.

The analysis of work-related hospital readmissions can help put a lower boundary on the rates of serious, non-fatal occupational injury and illness. More research is needed to refine the estimates of readmission rates and their impact on estimated injury rates used for surveillance. This analysis has been an exploration of the use of the HDD data for occupational health surveillance. There is a great deal of information in the database that has not been fully exploited for this analysis. At a minimum, additional research is needed to address some of the uncertainties discussed above. Additional efforts should be made to make full use of these data to further characterize the extent and nature of work-related hospitalizations.

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Appendix B: Diseases Of The Musculoskeletal System And Connective Tissue, ICD-9 Codes 710-739

Arthropathies and related disorders (710-719)

710 Diffuse diseases of connective tissue
711 Arthropathy associated with infections
712 Crystal arthropathies
713 Arthropathy associated with other disorders classified elsewhere
714 Rheumatoid arthritis and other inflammatory polyarthropathies
715 Osteoarthrosis and allied disorders
716 Other and unspecified arthropathies
717 Internal derangement of knee
718 Other derangement of joint
719 Other and unspecified disorder of joint

Dorsopathies (720-724)

720 Ankylosing spondylitis and other inflammatory spondylopathies
721 Spondylosis and allied disorders
722 Intervertebral disc disorders
723 Other disorders of cervical region
724 Other and unspecified disorders of back

Rheumatism, excluding the back (725-729)

725 Polymyalgia rheumatica
726 Peripheral enthesopathies and allied syndromes
727 Other disorders of synovium, tendon, and bursa
728 Disorders of muscle, ligament, and fascia
729 Other disorders of soft tissues

Osteopathies, chondropathies, and acquired musculoskeletal deformities (730-739)

730 Osteomyelitis, periostitis, and other infections involving bone
731 Osteitis deformans and osteopathies associated with other disorders classified elsewhere
732 Osteochondropathies
733 Other disorders of bone and cartilage
734 Flat foot
735 Acquired deformities of toe
736 Other acquired deformities of limbs
737 Curvature of spine
738 Other acquired deformity
739 Nonallopathic lesions, not elsewhere classified