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Weekend Woodsmen: Overview and Comparison of Injury Patterns Associated with Power saw and Axe Utilization in the United States

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Abstract

Introduction—Power saw and axe injuries are associated with significant morbidity and are increasingly managed in the emergency department (ED). However, these injuries have not been summarily reported in the literature. We aim to evaluate and compare the common injury patterns seen with use of power saws and axes.

Materials and Methods—Data from the National Electronic Injury Surveillance System- All Injury Program (NEISS-AIP) database was analyzed during 2006 to 2016. All patients with nonfatal injuries relating to the use of power saws or axes were included. Baseline demographics type and location of injuries were collected. Descriptive statistical analyses were performed using Chi Square or Fisher's exact test.

Results—Information on (n=18250) patients was retrieved from the NEISS-AIP database. Injuries were caused by power saw n=16384 (89%) and axe n=1866 (11%) use, and mostly involved males (95%). The most frequently encountered injury was laceration axe n=1166 (62.5%); power saw n=11298 (68.9%). Approximately half of all injuries in both groups involved the fingers and hand. Most injuries occurred at home (65%) and were attributed to power saw use (89%).

Conclusions—Power saws and axes can cause significant injuries, the majority of which occurred at home and were primarily associated with power saw use. Lacerations and injuries to the finger and hand were prevalent in both study groups. Further research into power saw and axe injuries should place emphasis on preventative measures and personal protective equipment (PPE).

Level of evidence—IV

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Study type—Retrospective review**Keywords**

Power saw; axe; trauma; injury pattern

1 Introduction

The cultivation of forests for pulp, wood, and myriads of tree byproducts continues to be essential for human habitation, creativity, and economy [1]. The ability to rapidly disassemble trees for making usable byproducts, whether in their natural or processed form has been associated with major societal benefits. As power saws and axes have become more readily available, injuries previously confined to the occupation of logging and carpentry now increasingly occur in laypeople. With the continual expansion and growth of these industries and availability of these tools to casual users, the frequency and severity of concomitant injuries is likewise on the rise [2]. These injuries have not been sufficiently reported in the literature, hence posing limitations to our comprehension and capacity to provide optimal emergency care or injury prevention to this cohort of trauma patients. We hypothesize that utilization of power saw and axes in laypeople will display distinct injury patterns arising from differences in anatomical locations and mechanism of injuries involved. In this paper, we endeavored to evaluate and compare the pattern and frequency of axe and power saw related injuries in patients presenting to emergency departments in the United States.

2 Methods

Using an established statistically valid injury surveillance system, the NEISS-AIP (National Electronic Injury Surveillance System- All Injury Program) database, we analyzed data pertaining to emergency department (ED) visits for power saw and axe related injuries during 2006 to 2016 (3). The NEISS-AIP database has been governed by the United States Consumer Product Safety Commission (CPSC) since 1972 and maintains a public database containing information on non-fatal injuries and poisoning incidents from approximately 100 nationally selected representative hospitals with a 24 hour ED and six or more beds, and is used as an illustrative sample estimate of injuries seen in hospitals within the United States.

We retrospectively searched for pre-specified CPSC product and injury codes to compare power saw and axe related injuries and their corresponding patterns (4). We defined power saw as product codes 1411 (chain saw), 0843 (radial arm saw), and 0845 (type of saw not specified). We defined axe as product code 1426 (hatches and axes). Male and female patients of all ages presenting to the ED from 01/01/2006 to 10/29/2016 with nonfatal injuries relating to the use of power saw or axe were included. Patient demographics, type and extent of injury and anatomical location of injury was collected for both groups.

To reduce variability of data, only targeted information was collected using CPSC diagnosis codes to categorize injuries. These injury codes are outlined in Table 1. Each of these were stratified based on the tool being utilized (power saw versus axe) and were also compared

overall. Injury location was also classified. Descriptive statistical analysis was performed using JMP software version 10.0.0 (SAS Institute, Inc). For normally distributed values, mean with standard deviation (SD) and for non-normally distributed values, median with [interquartile range, IQR] were reported. Comparison between power saw and axe injury demographics, injury patterns, and outcomes was assessed using Chi Square or Fisher's exact test. Statistical significance was considered at a $p < 0.05$.

3 Results

A total of 18250 ED visits secondary to power saw and axe injuries were retrieved from the NEISS-AIP database during the study period. Injuries occurred predominantly among males ($n=17347$, 95%) while only ($n=3$, 0.03%) were female and sex was not recorded in ($n=900$, 4.97%). Patient race included not stated ($n=5226$, 28.6%), white ($n=11242$, 61.6%), black/African American ($n=745$, 4.1%), other ($n=890$, 4.8%), Asian ($n=117$, 0.6%), American Indian/Alaskan Native ($n=24$, 0.1%), and Native Hawaiian/Pacific Islander ($n=6$, 0.2%). Overall, two thirds of injuries occurred at a patient home ($n=11881$, 65%) and nearly a third of injury location was not recorded ($n=6030$, 33%), remaining injury locations were negligible. Patients were predominantly in their fifth decade (median [IQR] age 49 [35–62] years). There were individual cases where fire was involved with the axe or saw injury ($n=8$). Overall within the cohort the three most common anatomic injured sites included fingers/digits ($n=10121$, 55%), hand ($n=1855$, 10%), and knee ($n=959$, 5.2%). The diagnoses for the cohort overall are noted in Table 1. The overall amputation rate was 6.7%. Finally, the disposition for patients within the cohort included the following: treated and released ($n=16756$, 92%), treated and admitted to same hospital ($n=1023$, 5.6%), treated and transferred to another hospital ($n=282$, 1.5%), left against medical advice ($n=109$, 0.6%), held for observation ($n=78$, 0.4%), in hospital mortality ($n=1$) and not recorded ($n=1$).

Of the 18250 injuries evaluated, 1866(10.2%) were related to axe utilization and 16384(89.8%) were associated with power saw utilization. Comparison of axe and power saw injuries demonstrated differences between the injury patterns Table 2. Comparing patients with axe injuries to power saw injuries, these patients were younger median [IQR] age (50 [37–63] versus 77 [28–50] years, $p=0.001$) and were more frequently female (12.4% versus 4.1%, $p=0.001$). No difference was noted between power saw or axe injury groups based on the most common race groups: black (2.7% versus 4.2%, $p=0.4$), white (61.3% versus 64.1%, $p=0.6$) or for no stated race (28.5% versus 29.9%, $p=0.5$). When comparing the three most common injury locations (home, or public property), power saw injuries more frequently occurred in each locale compared to axe injuries, (Figure 1). In Figure 2 the body parts affected in descending order based on axe or power saw is outlined. Axe injuries were more frequently associated with sprain/strain compared to power saw injury (9.4% versus 1.6%, $p=0.001$). Conversely, there were similar rates of laceration (62.5% versus 68.9%, $p=0.3$) and fracture (6.3% versus 9.5%, $p=0.4$) between groups. The amputation rate was dramatically increased in patients utilizing power saws compared to axes (7.3% versus 2.6%, $p=0.001$). On evaluation of patient disposition, there were no major differences between those injured by axes or power saws with respect to treated and released or treated and transferred to another hospital, left against medical advice, or held for observation; however, there was an increased rate of patients who were injured by power saws that were treated

and admitted to the same facility when compared to those injured by axes (6% versus 1.6%, $p=0.001$).

4 Discussion

Historically, the profession of logging was performed by scores of men subject to the raw dangers of falling trees and trauma secondary to wayward saws or axes. Remarkably, the first chain saw was invented not by a woodsman but by two Scottish physicians, Drs. John Aitken and James Jeffray, for obstetric and orthopedic procedures respectively [5]. While this saw was handoperated and somewhat arduous to use, the present-day motorized equivalent delivers improved ergonomic functionality. The gasoline or electrically powered saw is capable of making thousands of revolutions per minute and is able to swiftly cut through thick sections of wood with relative ease provided optimal maintenance and correct use. The rapidly rotating chain or blade in combination with the interrupted edge of the saw can generate powerful injurious forces when in contact with skin, soft tissue or underlying bone structures [5].

Our analysis of the NEISS database demonstrated that hands and digits are the most frequently injured in power saw accidents. Previous work demonstrated that hand related trauma comprised a significant proportion injuries sustained [6–8]. Our appraisal of NEISS data confirm prior work, wherein an overwhelming majority of patients in our study population sustained laceration injury from power saw use [2]. Primarily, these injuries result from a phenomenon known as kickback [5, 6, 8, 9]. Kickback occurs when the rotating chain comes into contact with a hard object, eliciting a sudden and powerful opposing force strong enough to cause the saw to “kick back” towards the individual operating the device [8] [12]. The resulting damage corresponds anatomically to the manner in which the saw was held immediately prior to this happening. For instance, the face, neck and upper limbs are more likely to incur damage when the saw is used to cut upwards as opposed to the groin and lower limbs when the saw is used to cut downwards [8].

Power saws are principally designed for dextral handed use, hence any left handed individual failing to learn the conventional way of operating a saw potentially poses an increased risk of harming themselves [13]. By nature of its design, the user is compelled to point the saw towards the left side of the body [6] [13]. This motion aims the blade just slightly over the left thigh and subsequently increases one’s risk of causing left-sided injuries [14]. The NEISS Database does not include data on hand dominance and so our study is unable to draw clear conclusions regarding this factor. However, in a review of 330 chainsaw injuries, Haynes and colleagues determined that 68% of injuries were encountered on the left side of the body [6]. Similarly, other studies have reported higher frequencies of injuries on the left side of the face and body [2] [6] [11]. This suggests that predominately dextral handed operators are subject to a potentially increased rate of left sided injuries.

Within our study population, injuries secondary to the use of an axe or hatchet were less common. The literature does not accurately describe axe-related injuries and our study improves on this relative lack of information by highlighting common injury patterns seen with axe use. Our results demonstrate similar findings pertaining to injuries sustained

secondary to the mechanics of axe swinging. Additionally, strains and sprains, which are injuries that affect the joints (i.e. tendons and ligaments) and muscle, were encountered more frequently in axe users. A swinging motion, which serves to increase momentum and to generate additional force when striking an object, is required when utilizing this tool. This predisposes users to back, shoulder, elbow, wrist and hand injuries [16–18]. Although an axe is also capable of causing considerable injuries, utilization of proper swinging technique and a firm grasp on the handle may reduce injury.

Similar to our findings with power saw injuries, lacerations were the most frequently encountered injury seen with axe use. The sharp cutting edge of the axe produces a smooth and straight, rather than jagged, pattern of injury to the afflicted soft tissue. In particular, the thumb and index finger of the non-dominant hand are commonplace locations on the body to be injured [15]. We have found the digits and hands to be the most susceptible to harm. Power tools have the capacity to cause more accidental injury than their non-powered counterparts [19]. When properly used, the sheer power of the tool is valuable and advantageous to loggers and woodworkers alike. Nevertheless, and contradictory to the very intention of this feature, a possibility exists for operators to lose control of the rapidly rotating saw and subsequently inflict bodily harm.

Logging and woodworking injuries occur at comparatively higher rates at home than they do at work or elsewhere [9]. Inadequate tool safety education in addition to the lack of personal protective equipment places laypeople in potentially increased odds to encounter bodily injury while using these tools [20]. The absence of counseling on the appropriate use of woodworking equipment or implementation of safety regulations in the home environment are additional factors accounting for the higher incidence of injuries sustained at home [9]. We demonstrated a significant proportion of injuries also occurred at patients' homes. These data reinforce the need for appropriate training, adequate personal protective equipment, and maintenance of a safe working environment to minimize injury to self or others.

There was an overall amputation rate of 6.7%. This is significantly lower than previously reported data wherein rates of amputation ranged (28–35%) (21–23). The reduction of amputations may be due to a variety of reasons including a lack of reporting the product associated with the injury or increased safety measures undertaken by the operator. It is also possible that products are increasingly created with failsafe devices to minimize amputation. Interestingly, we demonstrated an increased rate of amputation in those injured in power saw accidents compared to axe related injuries. This suggests that the mechanical aspect of woodcutting still contributes significantly to potential danger when compared to axes and operators should be mindful.

This study has several limitations; importantly this representative sample may not encompass all power saw and axe related injuries. Fatalities that occur prior to presentation to the ED are not captured in the NEISS database. Furthermore, injuries sustained by professional loggers and woodworkers may have been treated by designated medical professionals at the worksite or by a family physician without necessitating a visit to a participating NEISS emergency department. Those who sustained less severe and less

complex injuries, possibly secondary to axe use, either at home or at work may alternatively choose to self-treat their wounds and not seek professional medical care.

With advancement of technology and the advent of remarkably powerful tools, it is plausible to presume that the utilization of a power saw is favorable to an axe, in particular as home heating has evolved in many areas to be non-wood fueled. This may possibly explain the lower number of reported injuries secondary to axe use.

5 Conclusion

Power saws and axes have the potential to cause significant harm. Within the NEISS database, the preponderance of injuries resulted from power saw use with laceration injuries being the most prevalent overall. Our data further demonstrates that fingers and hands were most frequently involved in power saw and axe accidents, and these injuries occur at approximately the same rate in both groups. Additionally, the majority of injuries took place at home, rather than in the working environment. Future research for power saw and axe injury should be tailored around injury prevention and increased utilization of personal protective equipment (PPE).

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Figure 1.

Figure 2.

Table 1

Distribution of types of injuries associated with power saw and axe use.

Diagnosis	Total Injuries n (%) n=18250
Laceration	12464 (68.2)
Fracture	1663 (9.1)
Amputation	1253 (6.7)
Contusion, Abrasion	776 (4.2)
Avulsion	555 (3.0)
Strain or Sprain	440 (2.4)
Other/Not Stated	426 (2.3)
Foreign Body	362 (1.9)
Internal organ injury	63 (0.3)
Puncture	57 (0.3)
Crushing	34 (0.1)
Hematoma	29 (0.1)
Burns (thermal)	25 (0.1)
Nerve damage	22 (0.1)
Concussions	21 (0.1)
Dermatitis, Conjunctivitis	20 (0.1)
Dislocation	14 (0.1)
Hemorrhage	9 (0.1)
Anoxia	5 (0.1)
Dental Injury	4 (0.1)
Electric Shock	2 (0.1)
Poisoning	2 (0.1)
Ingested foreign object	1 (0.1)
Aspirated foreign object	1 (0.1)
Burns (chemical)	1 (0.1)
Burns (radiation)	1 (0.1)

Table 2

Comparison of injury diagnoses between power saw and axe utilization

Diagnosis	Power saw N=16384	Axe N=1866	P
Laceration	11298 (68.9)	1166 (62.5)	0.300
Fracture	1548 (9.5)	115 (6.3)	0.400
Amputation	1203 (7.4)	50 (2.7)	0.001
Contusion, Abrasion	643 (3.9)	133 (7.2)	0.010
Avulsion	519 (3.1)	36 (1.9)	0.161
Strain or Sprain	264 (1.6)	176 (9.4)	0.001
Other/Not Stated	336 (2.0)	90 (4.9)	0.078
Foreign Body	313 (1.2)	49 (2.6)	0.432
Internal organ injury	53 (0.3)	10 (0.5)	0.180
Puncture	45 (0.3)	12 (0.6)	0.333
Crushing	27 (0.2)	7 (0.4)	0.630
Hematoma	24 (0.2)	5 (0.2)	0.500
Burns (thermal)	23 (0.2)	2 (0.1)	0.700
Nerve damage	19 (0.1)	3 (0.1)	0.700
Concussions	18 (0.1)	3 (0.1)	0.700
Dermatitis, Conjunctivitis	18 (0.1)	2 (0.1)	0.700
Dislocation	11 (0.1)	3 (0.1)	0.700
Hemorrhage	7 (0.1)	2 (0.1)	0.700
Anoxia	5 (0.1)	0 (0)	0.910
Dental Injury	3 (0.1)	1 (0.1)	0.910
Electric Shock	2 (0.1)	0 (0)	0.910
Poisoning	2 (0.1)	0 (0)	0.910
Ingested foreign object	0 (0)	1 (0.1)	0.910
Aspirated foreign object	1 (0.1)	0 (0)	0.910
Burns (chemical)	1 (0.1)	0 (0)	0.910
Burns (radiation)	1 (0.1)	0 (0)	0.910