The Health Burden and Direct Health Care Costs of Acute Isolated Upper Extremity Trauma in Ontario

By

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Abstract

Acute hand and wrist trauma, a top reason for emergency department (ED) visits internationally, is an understudied public health issue in Canada. This research sought to characterize the burden of isolated hand, wrist and specific proximal upper extremity trauma (UET) in Ontario, Canada using linked administrative healthcare data between 2006-2016. Study one identified that UET in adults age 18-65 is the most common reason for ED visits (incidence rate: 211/10,000 person-years). Repeated episodes represented 24.8% of all ED visits, creating a large burden of preventable visits. Study two estimated the three year attributable cost (AC) of surgical UET using an incidence-based propensity score matched cohort study. The estimated AC of severe UET was $7519.80 and $8528.90 at one and three years, respectively. The AC translates into approximately $36 million annually for surgical UET, which accounts for only 2.5% of all episodes, indicating a substantial burden created by the entire cohort.

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List of Abbreviations

ACG – Adjusted Clinical Groups

CAD – Canadian dollars

CCAC - Community Care Access Centres

CCHS - Canadian Community Health Survey

CCI – Canadian Classification of Health Interventions

CCP - Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures

CCRS - Continuing Care Reporting System

CIHI - Canadian Institutes for Health Information

CIHI DAD – Canadian Institutes for Health Information Discharge Abstract Database (same as DAD)

CMI - Case Mix Index

CPWC - Cost per Weighted Case

CTAS – Canadian Trauma Acuity Score

DAD - Discharge Abstract Database

ED – Emergency Department

HCD - Home Care Database

ICD-10(-CA) - International Statistical Classification of Diseases and Related Health Problems, 10th Revision (Canadian version)

ICES - Institute for Clinical Evaluative Sciences

LHIN - Local Health Integration Network

LOS – Length of Stay

LTC - Long Term Care

MDS - Minimum Data Set Resident Assessment Instrument MDS-MH Minimum Data Set for Mental Health

MHA – Mental health and addiction

MOHLTC - Ministry of Health and Long Term Care

NACRS - National Ambulatory Care Reporting System xiii

NRS – National Rehabilitation Reporting System

ODB - Ontario Drug Benefit

OHCAS - Ontario Home Care Administrative System OHIP - Ontario Health Insurance Plan

OMHRS – Ontario Mental Health Reporting System QALY - Quality Adjusted Life Year

RAI-MH - Resident Assessment Instrument-Mental Health RCW - Rehabilitation Cost Weight

RIO - Rurality Index for Ontario

RIW - Resource Intensity Weight

RPDB - Registered Persons Database

USD – United States dollars

Chapter 1: Background, Rationale and Objectives

1.1 Organization of Thesis

This thesis consists of two major studies: an epidemiology study and a longitudinal direct health care costing study. These will be presented separately. Chapter 2 will present the methodology for both studies. Chapter 3 will present the results of Study 1 and Chapter 4 will present the results of Study 2. Chapter 5 will present the discussion, limitations, conclusions and future directions of both studies.

1.2 Hand, Wrist and Upper Extremity Trauma – Why is this an important health issue?

"*The hand is the tool of tools*." ~ *Aristotle*

Our hands are essential for interacting with our environment through communication, exploration, protection and task completion. When one or both hands are injured, there is a sudden disruption in one's capacity to interact with one's environment, having implications for managing in everyday life and work [3,4]. Hand and upper extremity trauma includes a broad spectrum of diagnoses due to the complex nature of the anatomy and the range of injury severity. Some forms of trauma require surgical intervention and others require lengthy immobilization. Others require little more than basic First Aid. The hand and wrist have many articulations, which very quickly lose motion after surgery or periods of immobilization, thus requiring physical therapy after the acute care phase is completed.

Hand and wrist injuries are an extremely common presentation to the emergency department (ED) with young and economically productive individuals typically the population most affected[4–7]. The average duration of absenteeism from work following hand and wrist trauma has

been reported to be 1-3 months [4,6,8]. Hand and wrist injuries can leave permanent disability, depending on the injury type and severity leading to lifelong implications for an individual's ability to participate in vocational and avocational activities. Reports of indirect costs through lost opportunity for patients has been shown as a greater contributor to the economic burden of hand and wrist trauma than direct healthcare costs.[5,6] Although these injuries are rarely life threatening, they have tremendous implications for patient quality of life and employment and may require long periods of treatment and rehabilitation, resulting in an economic burden for the patient and the health care system.

1.3 Epidemiology of Hand and Wrist Trauma

Hand and wrist trauma is one of the most common presenting complaints to the emergency department (ED) in the United States, Europe and Australia [4,5,7,9–11]. The first population-based study of hand and wrist trauma epidemiology was conducted in Denmark [9] from 1990-1991 using patient data for the Danish segment of the population, acquired in the European Home and Leisure Accident Surveillance System (EHLASS). The authors reported that hand and wrist trauma represented >15% of all presentations to the emergency department (ED) and translated into an annual incidence of 37 hand and wrist traumas/10,000 persons per year. Other European studies have reported high representation of hand and wrist trauma in the ED accounting for 12-20% of all visits.[4,5] A Swedish study reported that hand injuries represented 12% of ED visits between 1989-1997 with an annual incidence of 70 hand and wrist traumas/10,000 persons per year [10]. This study was limited to one facility in Malmo, Sweden. Data from the Dutch National Registry has demonstrated the annual incidence of hand and wrist trauma to be 1,575 cases/100,000 person-years between 2008-2012[5]. This annual incidence was substantially greater than the incidence of lower extremity trauma (490/100,000 person years) and head injuries (200/100,000 person years). Hand and wrist injuries represented nearly one third of all injuries in the Netherlands in

2007. The epidemiology of hand and wrist injuries in the United States has recently been described using data from the Health Care Utilization Project [7,12]. The authors of this study identified all patients with hand and wrist trauma as a cluster of diagnoses between 2009 and 2012. Patients presenting to the ED with any of these diagnoses resulted in nearly 8.6 million visits annually. The HCUP report in 2011 identified "abdominal pain" and "superficial injury" as the most common diagnoses associated with ED discharge, representing 4.02 million and 4.52 million ED visits, respectively, in 2011. In comparison, as a cluster of diagnoses, hand and wrist trauma presented to the ED in the United States with twice the frequency of these top ED diagnoses [7,13]. The authors also reported that the annual frequency of hand and wrist trauma is increasing in the US. A single centre study in Melbourne, Australia identified hand and wrist trauma as a major source of ED volume, representing 5.4% of all ED visits between 2014-2016. [11]

Although hand and wrist trauma appears to be a significant public health issue internationally, and specifically in countries with a similar economic conditions to Canada, there have been no studies describing the epidemiology and burden of illness of hand and wrist trauma in Canada. Further, while some of these epidemiologic studies highlight the need for primary prevention, there have been no studies that examine patterns of hand and wrist trauma and differences between demographic groups to understand these potential preventative strategies. For example, sex-differences have been apparent among studies describing the epidemiologic studies on hand and wrist trauma. Hand and wrist trauma is more common among men and men with hand and wrist trauma are generally younger than women that sustain hand and wrist trauma [4,5,7,13]. It also appears that the type of injury, location of injury and mechanisms may also vary depending on the sex of the patient [9,14]. A more detailed analysis of these differences could be useful in directing specific research questions on demographic differences in hand and wrist trauma and potential approaches to primary and potentially secondary prevention.

Trauma is a condition that has a high risk of recurrence [15–17]. Previous research has shown that patients admitted for trauma were much more likely to have had a previous trauma-related admission to hospital than emergency admissions that were not traumatic in nature [17]. Potential explanations for recurrent trauma include chronic high-risk behaviors, mental health and addiction disorders[17,18], younger age [19] and work related-conditions [20]. One study specifically compared the rate of unintentional injury recidivism in subjects with mental illness and subjects without mental illness. The study reported that 42% of subjects with a mental health diagnosis were unintentional injury recidivists while only 10% of the those without a mental health diagnosis had more than a single hospital visit for unintentional injury [21]. Previous studies in the general trauma literature have concluded that the behaviour-specific high-risk behavior should be evaluated for potential secondary preventative measures [17,22]. There have been no studies examining the epidemiology of repeated episodes of hand and wrist trauma to date. Understanding the factors that contribute to repeated hand and wrist trauma may help to reduce the potential burden that this condition creates for the health care system while promoting better outcomes and reduced risk of recidivism for hand and wrist trauma patients.

Socioeconomic status is known to influence health outcomes and treatment [23–25]. Specifically, access to health care and patient compliance are thought to be relevant and influential factors [26] There is little known about the relationship of socioeconomic status to hand and wrist trauma. Three European studies have applied the Carstairs score [27], a validated social deprivation score, in hand fracture and distal radius fracture populations[25,28,29]. These studies have not identified a relationship between incidence of distal radius, phalangeal or metacarpal fractures and social deprivation [25,28,29]. Younger males with distal radius fractures were more likely to be classified as socially deprived. There was no relationship between distal radius management and social deprivation. Among male phalanx and metacarpal fracture patients, a relationship was identified between the mechanism (e.g. assault, blows, crush injuries) and greater social

deprivation [28]. While there was no apparent relationship between social deprivation and the type or complexity of fracture patterns, there were differences in fracture management with more affluent patients having a greater likelihood of receiving operative treatment [28,29]. The explanation for differences in management have not been demonstrated but may relate to access to care or treatment bias [25,29].

The residents of Ontario comprise nearly 40% of the Canada population, having a large variation of urban and rural communities spread over the third largest province/territory. Canadians situated in closer proximity to healthcare affects their ability to access services with resultant better health [30,31] and may be relevant among the isolated hand and wrist trauma population. Using administrative healthcare datasets in this Ontario cohort of hand and wrist trauma patients will facilitate exploration of proxy markers of socioeconomic status in relation to hand and wrist trauma, including estimated neighborhood income quintile, the Rurality Index of Ontario and the Ontario Marginalization Index (described below). These covariates will be incorporated into the matching protocol for study 2 (described below).

1.4 Cost of Illness in Hand and Wrist Trauma

Internationally, hand and wrist trauma is a substantial contributor to ED volumes, which naturally has the potential to translate into a costly issue for both the healthcare system and for hand and wrist trauma patients. There have been a number of studies internationally that have attempted to estimate direct, indirect and intangible costs associated with acute hand and wrist injuries [4–6,32–41]. These studies have provided isolated descriptions of the economic burden of hand and wrist trauma in specific health systems.

These studies have employed variable costing methodologies [42,43], including estimations of the economic burden of disease, direct medical costs, direct non-medical costs, indirect costs and

intangible costs. Economic burden of disease provides a sum of all associated costs incurred as a result of a condition. This methodology takes a societal approach including direct, indirect and intangible costs [5,6,42,44–46]. Direct medical costs represent the costs of managing a particular condition (e.g. diagnostics, surgery, inpatient management, medications, imaging and postoperative care). Direct non-medical costs represent costs associated with receiving health services, but are not a health sector cost (e.g. transport to medical appointments). Indirect costs usually relate to productivity losses that arise as a direct result of the condition and include work absenteeism, presenteeism with reduced work capacity and reduced unpaid productivity (performing usual home activities). Indirect costs are more challenging to evaluate with accuracy relative to direct costs and are often not reported [42,43].

Two different approaches have been implemented for estimation of direct medical costs of hand and wrist trauma: top-down (population-based) approach or a bottom-up (person-based) approach. Top-down approach to cost estimation disaggregates total healthcare spending from the total health budget to healthcare sectors and then to facilities [47]. Top-down cost-estimation is usually comprehensive and ensures that all healthcare spending is allocated and accounted for. Top-down approaches are better suited for macro-level costing studies or meso-level studies for populations of interest [47].

Bottom-up or micro-level costing approaches start with individual encounters or utilization in the health system and attaches costs to each encounter. Costs per encounter may be derived from billing data or calculated based on attributable cost information. This approach allows for measurement or aggregation of individual healthcare costs for stratified analyses based on patient characteristics. Further, these costs are useful for estimating burden or cost of illness or and for cost-effectiveness studies. The limitation of micro-level costing is the inability to account for healthcare costs such as community health clinics and capital costs [47]. The majority of hand and

wrist trauma health care costing studies have utilized this approach [4,6,8,32–35,37–41].

A recent systematic review of cost-of-illness following hand and wrist trauma included fourteen international studies and has identified that the median cost estimate per case was $8207 USD (IQR $3858-$33,939) [43]. The studies incorporated into this review included specific hand and wrist trauma populations (e.g. scaphoid fractures, nerve injuries, osteoporotic wrist fractures [33,35–37,40,41,48–53] and all cases of hand and wrist trauma [4–6,8,32,34,38,39,54]. Some injury types were more costly than others). Non-specific hand injuries caused by saw and major nerve injuries had the greatest direct healthcare costs of $25,966 and $10,206 USD, respectively [38,41]. The non-specific acute hand and wrist trauma direct healthcare cost reports varied from $340 USD [34]to $6877 USD [8] for major hand injuries with the greatest cost associated with saw injuries ($25,966 USD) [38]. There have been reports of osteoporotic wrist fracture population direct healthcare costs that also demonstrate significant variation. In Slovenia, a population-based study reported a cost of $212 USD [36] compared to a Swedish study reporting per patient direct healthcare costs of $3323 [35]. Despite that both studies had rigorous methodology for cost estimation and reported costs up to one year, there is a substantial difference in direct healthcare cost, between countries. This discrepancy highlights the difference in the national setting including health systems, different pricing and reimbursement methods, different types and qualities of data, which can lead to considerably different results for a cost-of-illness study.

The majority of the cost-of-illness studies following hand and wrist trauma have been single centre studies [4,6,8,32–34,37–39,41] with small population samples. These studies may not provide a comprehensive assessment of the costs following hand and wrist trauma as they generally all used a bottom-up approach for cost estimation. Further, these studies tended to be focused on a specific population, leading to a lack of generalizability. Administrative healthcare databases have been implemented in the Netherlands and the United States to take a population-based approach to

understanding the cost-of illness following hand and wrist trauma. These studies have allowed for a comprehensive assessment of the acute costs of hand and wrist trauma.

The economic burden of acute hand and wrist injuries has been evaluated in the Netherlands [5,55]. The Dutch Injury Surveillance System was the main data source over the 2008-2012 period and provided a representative sample of 12% of the patients attending EDs in the Netherlands. Findings from these data were extrapolated to represent the entire Dutch population. Direct medical costs were calculated using an incidence-based cost model that calculated age- and injury-specific costs based on the estimated healthcare consumption of the individual patient [5,56]. Productivity costs were estimated using an absenteeism model [5,56]. The direct health care costs of hand and wrist trauma in 2007 were $329 million with lost productivity costs of $411 million among the entire population [5]. A follow- up study to this over 2008-2012 examined costs in working adults (20-64 years) in the Netherlands. Acute care costs in this Dutch single payer system were $103 million USD annually, but the economic losses for patients was nearly three times greater ($307 million USD), highlighting a source of stress for patients after hand injury[55]. Higher healthcare costs were associated with male sex and increasing age. The strength of these two Dutch studies is the comprehensive, population-based analysis. The duration of follow up for these Dutch Studies was not specified, which limits the interpretation with respect to longitudinal economic burden. Further, these costs were total costs as opposed to incremental costs, which may not provide the most accurate depiction of health care costs [57,58].

A recent US study of the epidemiology of hand and wrist trauma reported that the annual frequency of hand and wrist trauma is increasing in the US and is associated with rising costs of acute care episodes from $40.9 billion in 2009 to $48.6 billion in 2012 (net 18.8% increase)[7]. This annual approximate cost associated with these ED visits represents approximately 1.4% of the annual health care expenditure in the US ($2.9 trillion)[7]. The majority of these costs were derived

from inpatient encounters (7% of the patients) while approximately one third to one quarter of the total costs were derived from emergency room visits that resulted in discharge ($11.5 billion in 2009 to $15.9 billion in 2012).

A limitation of the previous healthcare costing studies from the US and the Netherlands is the lack of a longitudinal assessment of costs following the hand and wrist trauma. The cost estimations of these studies are limited to the costs associated with the acute episode. Longitudinal health care costing studies include acute care and subsequent health care costs for a defined period, including direct health care costs associated with follow up care or outpatient surgery. This provides health services researchers with a comprehensive picture of the economic burden to the health system for a particular issue. Further to this, there may be increased indirect health care costs such as visits to the ED, walk-in clinics, family physicians or other access such as mental health and addiction (MHA) service utilization that arise secondary to the initial event, in this case, the hand and wrist trauma. As such, the overall direct costs arising from a condition, such as hand and wrist trauma, may be underestimated. Over a longer interval of time following an injury, it may be difficult to identify if a specific episode of healthcare utilization is, in fact, attributable to the diagnosis of interest. In order to address this issue, an incremental or attributable cost approach can be employed. When working with observational datasets from administrative healthcare databases, attributable costs can be identified by matching to a control group that lacks the same diagnosis (in this case, hand, wrist and specific upper extremity trauma) to the cases. The healthcare costs accrued over a set period of time are then compared between matched cohorts. Using an attributable cost methodology provides the most accurate representation of the portion of health care cost related to the condition of interest[57,58]. This approach also allows for easier comparison between international studies as the differences in healthcare costs, reimbursement, etc. that naturally exist internationally, are normalized to a greater extent than comparing the absolute value of the direct healthcare cost. Longitudinal costing studies for other trauma

populations have demonstrated the substantial attributable health care costs for up to ten years after the index event[59,60]. There are no studies of this type to describe the longitudinal patient-level costing following hand and wrist trauma, yet these patients often have prolonged care involving hand therapy, follow up appointments and reconstructive surgery. This methodology was incorporated in study 2.

1.5 Longitudinal Healthcare Costing Studies and Management of Confounding Variables

Using observational data from administrative databases to estimate outcomes, such as longitudinal costs, can be problematic. Individuals that have an exposure, such as hand and wrist trauma, may have a number of characteristics (e.g. mental health issues) that are not shared by individuals that have not had the exposure of interest. If the associated characteristics are related to the outcome of interest, these would then represent confounding variables. These confounding variables must be addressed in the experimental design stage or in the analysis stage when using observational data. Restriction allows for reduction of confounding at the study design phase by restricting the inclusion criteria based on a confounder [61]. In this study we have incorporated this as we have restricted our population of interest to adults ranging from 18-65 years. This approach may limit the generalizability of the study and will require further studies to examine similar questions among the pediatric and older populations in Ontario. When working with large administrative data sets confounding can be addressed at the analysis stage using instrumental variable analysis, regression or matching. A stratified analysis is also a means for balancing known confounders and can be useful for demonstrating the effect of the confounding variable on the outcome; however, this approach is limited as the number of confounding variables is increased [62].

Instrumental variable analysis can be employed when there is a confounding variable that is not related to the outcome (e.g. longitudinal healthcare costs) and is highly correlated with the explanatory variable (e.g. whether or not a hand and wrist trauma has occurred) [63]. This approach was not considered for this study of hand and wrist trauma as there were no identified instrumental variables.

A regression analysis controls for confounding by fitting data to an equation that incorporates a key variable for the exposure of interest (e.g. hand and wrist trauma) and a set of covariates thought to confound the outcome or the dependent variable (e.g. healthcare costs). The model is then evaluated for how well it is specified and may need to be revised if misspecified, as this could lead to biased results [64].

Confounding observational data can be managed by matching those subjects with an exposure to a control group that lacks the same exposure (in this case, hand and wrist trauma), usually with propensity score matching. Propensity score matching is a more efficient means to handle many confounders simultaneously. A propensity score is a balancing score that represents the likelihood that an individual would have an exposure of interest, such as hand and wrist trauma, and varies from 0 to 1. There are two steps involved with calculating a propensity score. First, a logistic regression model is fit with the exposure of interest (hand and wrist trauma) as the dichotomous variable. The same regression model is used to calculate the propensity scores for each subject and potential match(es). After calculating the propensity scores, subjects are matched to controls based on the propensity score, producing two cohorts with balanced baseline characteristics. [65,66]. A comparison of the standardized differences of the measured variables (a difference of 10% or less) then determines how well the two groups are balanced, and revisions to the model are performed until balance is achieved [67]. Once the cases are matched to the controls using propensity scores, the outcome of interest can be compared directly as in a randomized

control trial. In order to take into account the paired nature of the data, statistical tests for paired analyses are recommended [65]. Propensity score matching was incorporated in our study in order to evaluate the attributable longitudinal direct healthcare costs of hand and wrist trauma.

1.6 High Cost Patients in Hand Surgery

The evaluation of longitudinal health care costs following hand and wrist trauma will translate into a better understanding of the subpopulations that have greater needs and utilize the greatest amount of resources. These subpopulations are termed high-cost patients, and are small groups that are responsible for a disproportionately large share of the health care costs.[68] Recently, high-cost patients have become a focus of policy makers as potential for targeted programs that could reduce overall costs while simultaneously improving patients' health and care experiences.[68,69] Patient subpopulations known to be high cost patients are elderly patients, those with high comorbidity, and patients with lower socioeconomic status, mental health diagnoses, and addictions.[70,71]

MHA patients are one subgroup of high-cost patients generating up to 30% greater health care costs than patients without MHA.[70,71] Further, patients with any MHA service utilization have demonstrated approximately 40% greater health care costs than those that did not access MHA services.[72] This phenomenon is likely explained by an increased risk of developing chronic physical conditions and susceptibility to worse health outcomes faced by MHA patients.[73] The literature would imply that interventions and policies targeted at high-cost patients should try to address both their physical and mental health, where appropriate, in order to reduce cost and improve outcomes.

1.7 Mental Health and Addiction Access and Hand and Wrist Trauma

Psychological distress shapes the recovery pathway in patients with orthopedic trauma and is associated with the likelihood of persistent disability, chronic pain, and a diminished sense of well-being.[74–78] Patients with pre-morbid and those that develop post-traumatic MHA needs are potentially different in their demographic features, the nature of their injuries and their needs following trauma to address psychosocial issues. Identifying these differences may yield insight into potential avenues for primary preventative strategies. Of equal importance is the role of this information for directing secondary preventative strategies to reduce repeated episodes of trauma and improve outcomes. The information garnered from research with a focus on MHA can further support and direct appropriate MHA screening, which currently has little evidence for guiding such programs.[78] In concert with appropriate screening are the needs for timely and appropriate access to MHA support. There is evidence that for those exposed to trauma, ongoing non-traumatic stressors are predictive of PTSD onset and substance use issues.[79,80] The goal of secondary prevention would be to intervene before MHA issues escalate to inhibit progress with rehabilitation, in order to promote better outcomes following hand and wrist trauma. Such interventions might play a role in reducing repeated episodes of hand and wrist trauma, making a cost-effective strategy by reducing future health care costs.

It is known that patients with MHA are less likely to be engaged in ongoing care, which is thought to be the main culprit in poorer health outcomes.[73] In the general trauma population, pre-existing MHA patients are at increased risk of developing chronic pain issues and acute complications following musculoskeletal injuries.[81–83] In relation to hand and wrist trauma, there is good evidence to support that the severity of symptoms experienced and level of disability are associated with psychosocial issues.[84–86] Development of patient centred approaches to care that address both physical and psychological needs of the patient are gaining popularity as a means to improve patient engagement in ongoing care to achieve better health outcomes.[73] At our institution, the comprehensive rehabilitation programs such as cardiac, pulmonary and transplant

rehabilitation are interdisciplinary programs that offer multi-faceted care, including physical and psychological rehabilitation, education and risk factor modification. These models have demonstrated benfits such as improved engagement in care, earlier return to work and decreased complications.[87]

1.8 Rationale

Hand and wrist trauma is a significant public health issue in many other countries and most likely this is also true in Canada. In order to understand the overall magnitude of an issue and to design future research that will address knowledge gaps and suggest potential solutions, we first need to understand the basic epidemiology of the population and describe patterns that may generate hypotheses about preventable sources of the problem (hand and wrist trauma).

Ultimately, high volumes of acute care for hand and wrist trauma have the potential to create a sizeable ripple effect for the health care system, requiring surgical and non-surgical follow up care over short and extended periods of recovery. While existing international data demonstrate the health systems cost of acute treatment of hand trauma, there is little known about longitudinal health care costs, specifically in Canada, and variation in costs within sub-populations. This information identifies a key population for targeted needs assessment and program development with the overall goal of improving hand and wrist trauma care outcomes and timely return to work and life activities. Of particular interest in this thesis work is the interplay between pre-morbid or post-traumatic MHA issues among the hand and wrist trauma population.

With respect to hand, wrist and specific upper extremity trauma in Ontario, we hypothesize the following will be identified:

1. Hand and wrist trauma represents a significant public health issue in Ontario with the potential for primary and secondary preventative strategies

2. Potential sources of increased health care utilization exist among hand and wrist trauma patients, such as repeated episodes of hand and wrist trauma
3. There is be substantial long-term direct health care costs associated with isolated surgical hand and wrist trauma
4. Certain patient populations have increased costs following hand and wrist trauma, allowing for future delineation of high cost hand and wrist trauma populations.

Chapter 2: Methods

2.1 Preface

This chapter describes the research methods utilized in the two studies incorporated into the body of this thesis. The first study is an epidemiological study of isolated hand, wrist and specific upper extremity trauma in Ontario. This chapter will provide detail on the identification of the inception cohort for the epidemiologic study and stratified univariate analyses of the cohort.

The second study is a longitudinal health care costing study of surgical hand and wrist trauma. This chapter delineates the analytic strategies utilized in Study 2 to control for confounding variables in estimating attributable costs, including matched sampling, propensity scores and difference in differences methodologies. There will be a description of the databases utilized for cohort identification (both hand and wrist trauma cases and controls) and associated covariates and outcomes.

2.2 Study Design

2.2.1 Study 1: Epidemiology of Adult Hand Trauma in Ontario

The first study was a descriptive retrospective cohort study using Ontario health care administrative data from April 2006 to March 2017.

2.2.2 Study 2: Attributable Long-term Costs of Adult Hand and Wrist Trauma in Ontario

This study was an incidence-based propensity score matched cohort study to evaluate the attributable costs of hand and wrist trauma using Ontario population health administrative data from April 2006 to March 2017. The perspective was that of the Ministry of Health and Long-Term Care for Ontario, including only direct medical costs borne by the payer.

2.3 Study Objectives

2.3.1 Objectives for Study 1: The Epidemiology of Hand and Wrist Trauma In Ontario

The primary objective of this study is to provide a descriptive analysis of the epidemiology and temporal changes of isolated hand and wrist trauma in the province of Ontario between April 1, 2006 and March 31, 2017. Specifically, the aims of study 1 are:

1. To define the annual incidence of all episodes, index episodes and recurrent episodes of isolated hand, wrist and upper extremity peripheral nerve trauma presenting to the ED among adults in Ontario
2. To describe demographic factors and mechanisms associated with isolated hand and wrist trauma in Ontario
3. To conduct univariate analyses based on sex, age, hand and wrist trauma recidivism and pre-morbid mental health issues to generate a better understanding of hand and wrist trauma patterns
4. To describe the temporal trends of hand and wrist trauma presenting to the ED in adults
5. To explore the burden on the health care system through increased utilization imposed by the large volume of adult hand and wrist trauma presenting to the ED, including a description of hand and wrist trauma recidivism and hours of ED care dedicated to this issue.

2.3.2 Objective for Study 2: Attributable Long-term Health Care Costs of Surgical Hand and Wrist Trauma

The primary objective of this study is to delineate the attributable long-term direct health care costs, borne by the Ontario Ministry of Health, following hand and wrist trauma using a propensity score matched cohort of individuals that did not sustain a hand and wrist trauma.

The secondary objectives of Study 2 are:

1. To describe resource utilization by category following hand and wrist trauma, including hospitalization, inpatient/outpatient surgery, types of health care visits including ED, family physician or specialist and MHA services utilization.
2. To perform a stratified analysis of attributable long-term costs based on type of admission for surgery (acute admission vs. outpatient admission through same day surgery).
3. To perform a stratified analysis of attributable long-term costs based on demographic and injury factors including sex, age category and injury type.
4. To perform a stratified analysis of attributable long-term health care costs stratifying the cohort based in MHA service utilization either pre-hand injury or post-hand injury in order to identify potential high cost hand and wrist trauma populations.

2.3 Data Sources

Ontario population-based health administrative data housed at ICES was used for both studies conducted for this thesis. The Ontario population-based health administrative databases contain claims or records of nearly all publicly funded healthcare in Ontario. These data are gathered during the routine delivery of healthcare and provide real-world data reflecting what occurred in a patient care encounter. As such, the inferences based on these data are usually highly generalizable. These datasets are widely used for Ontario health services research, have multiple quality reviews [88–90] and incorporate established methods for costing studies.[47,91–93]

Some limitations to using administrative data relate to the nature of the data since they were not created for the purpose of conducting health research. Challenges can include identification of a specific cohort due absence of diagnosis or procedure codes or invalid use of diagnosis, procedure or billing codes. However, both primary diagnosis and procedure coding in

hospital is relatively accurate,[94] which is essential for the two studies conducted for this thesis. Relevant to this thesis, these validity studies have shown that demographic information was complete in > 97% in studied databases. Re-abstraction studies demonstrated that most responsible diagnosis in hospitalization and emergency department data had 85% agreement and coded procedures had at least 85% agreement.[95]

Some health services are not recorded in ICES datasets. These include outpatient occupational therapy, physiotherapy and psychological services, and the cost of drugs for individuals younger than 65 years or not on long-term disability or social assistance. For study two, there may be indirect health care costs of hand and wrist trauma incurred by patients or third party payers for which costs are unaccounted. Since study two was conducted from the perspective of the health system, these unaccounted costs did not represent a challenge in identifying attributable healthcare costs incurred by the provincial payer. Table 2.1 summarizes the databases being used for this research and their validity.

2.4 Cohort Identification

2.4.1 Study 1: Epidemiology of Isolated Hand and Wrist Trauma in Ontario

Episodes of hand and wrist trauma as the main diagnosis were identified using the National Ambulatorty Care Reporting System (NACRS) Emergency Department (ED) database between April 1, 2006 and March 31, 2017. NACRS ED contains data on hospital based data on emergency care visits in participating hospitals across Ontario. A primary ICD-10 code representing acute trauma to the hand, wrist, forearm or peripheral nerves at any level of the upper extremity (Appendix 2.1) was required. The codes were inclusive with wounds and crush injuries in the upper arm and shoulder region included, as these primary diagnoses can result in destructive soft tissue and nerve injuries that are treated by upper extremity and hand surgery subspecialists. Episodes of hand and

wrist trauma were excluded in the context of polytrauma. Polytrauma was idenfied by trauma codes other than hand and wrist trauma populating the ICD-10 diagnostic codes 2-10, representing trauma outside of the upper extremity (Appendix 2.2). Further, the cohort was limited to adult individuals (≥18 years and ≤65 years) in order to reduce variation in type and mechanism of injury. Individuals were also excluded if sex and/or age were missing, death date occurred before index date of hand and wrist trauma or no valid OHIP was present at time of index hand and wrist trauma in Registered Persons database. This cohort represented all episodes of hand and wrist trauma presenting to the emergency department. Repeated episodes of hand and wrist trauma occuring in the same subject (identified by IKN) were identified. Repeated episodes were further classified as being related to the index episode if the two episodes occurred within 30 days from each other and if there was the same primary diagnosis. True recurrent episodes were those that did not meet these criteria.

2.4.2 Study 2: Attributable Long Term Costs of Adult Hand and Wrist Trauma in Ontario

2.4.2.1 Index Surgical Hand, Wrist and Peripheral Nerve Trauma Cohort Identification

Index hand and wrist trauma episodes were the first episode of isolated hand and wrist trauma presenting to the emergency department identified using the NACRS ED database between April 2006 and March 2014. A primary ICD-10 code representing acute trauma to the hand, wrist, forearm or peripheral nerves of the upper extremity (Appendix 2.1) was required. A minimum four year look back window was applied (April 2002-March 31 2006; Figure 2.1). This four year look back period was chosen as a balance between a limited one-year lookback period and an unlimited lookback period. Population health studies of chronic diseases have demonstrated that short, fixed

lookback periods (e.g. 1 year) which can underestimate the prevalence and overestimate the incidence, while the converse is true for unlimited lookback periods.[96]

Although there are no defined guidelines for choosing a lookback window in either chronic or acute conditions, it is recommended that the chosen window reflect the knowledge of the typical duration of the illness. Based on the author's (HB) clinical experience, four years was a balanced choice to allow for resolution of a prior hand and wrist trauma without underestimating the incidence of hand and wrist trauma among the population. Patients with an episode of hand and wrist trauma occuring within the look back window were excluded to reduce the potential for residual health care costs associated with the prior hand and wrist trauma episode. Episodes of hand and wrist trauma were excluded when they occurred in the context of polytrauma . More specifically, hand and wrist trauma patients were excluded if diagnostic fields aside from the most responsible diagnosis were populated with ICD-10 codes representing trauma outside of the upper extremity (Appendix 2.2). The rationale for this exclusion was that we sought to identify direct medical costs specifically and exclusively related to hand and wrist trauma. Further, the cohort was limited to adult individuals (≥18 years and ≤65 years) in order to establish a more focused understanding of the direct medical costs associated with hand and wrist trauma in the adult population. Children[97,98] and older patients[99,100] potentially have different acute care needs following trauma and post-traumatic sequelae than adults such as longer hospital stays or greater propensity for post-traumatic mental health issues. Although this has not been studied in the hand and wrist trauma population, these populations were excluded in order to limit age effects in the estimation of direct health care costs. Due to the spectrum of diagnoses of hand and wrist trauma, only index episodes of hand and wrist trauma requiring surgery, as identified through the DAD or NACRS-SDS procedure codes (Appendix 2.3), were included. Individuals were also excluded if sex and/or age were missing, death date occurred before index date of hand and wrist trauma or no valid OHIP was present at time of index hand and wrist trauma in Registered Persons Database.

2.4.2.2 Non-upper Extremity Trauma Control Cohort Identification

Potential controls were OHIP eligible adults (≥18 years and ≤65 years). Each potential control was randomly assigned an index date corresponding to an index date in cases. A four year look back window was applied prior to the index(April 2002-March 31 2006; Figure 2.1). Subjects with an episode of hand and wrist trauma (primary or secondary) in the look back window or within three years following the assigned index event were excluded. Individuals were also excluded if sex and/or age were missing, death date occurred before index date of hand and wrist trauma or no valid OHIP was present at time of index hand and wrist trauma in Registered Persons database.

2.5 Long-Term Health Care Cost Identification

Only direct medical costs incurred by the Ministry of Health and Long-term Care were considered. Neither indirect costs such as out-of-pocket costs associated with the injury and subsequent care nor lost income were quantified or included.

2.5.1 Data Sources

All residents of Ontario receive complete coverage of medically necessary care. This coverage includes physician fees, diagnostic tests, homecare, emergency department and outpatient visits, admission to hospital, long-term care, complex continuing care, and rehabilitation, and partial coverage for adaptive devices, such as prosthetic equipment. Medications are provided to senior citizens, individuals younger than 25 years of age, individuals that receive social assistance, are permanently disabled or of have out-of-pocket drug costs greater than approximately 3% of their income. Health care utilization and the associated direct costs were determined using the health care administrative data that monitors usage or remuneration of healthcare providers for their services.

2.5.2 Estimation of Attributable Long-term Health Care Cost

Matching

Individuals with hand and wrist trauma may differ in measurable and unmeasurable ways from those that have not sustained a hand and wrist trauma. Propensity score matching was used in order to reduce confounding. Each isolated hand and wrist trauma case was matched to four controls without hand and wrist trauma. Close matching was conducted through two stages; first with hard matching followed by use of a propensity score.[47]

Hard matching is a means to control for a small number of confounding variables but does not account for bias resulting from the unobserved covariates that might determine whether a subject has the outcome of interest or not. Hard matching was based on demographic, health care utilization and clinical characteristics including index date, age at index (based on month and year of birth), sex, and presence or absence of mental health utilization in the year prior to index date. Hand and wrist trauma is more common in males [4,5,7,9,13] and younger subjects. Further, there is seasonal variation in hand and wrist trauma making the index date an important predictor for hand and wrist trauma. Further, since Candian healthcare is continually evolving, the time period of care may affect utilization and the quality or type of care. Mental health and addiction utilization was identified based on admission to hospital, visit to emergency department or outpatient services for mental health and addiction as primary diagnosis using a validated algorithm within a one year look back window from the index date.[72] Patients with MHA diagnoses prior to having any trauma are known to have increased risk of intentional injuries, such as self-harm or assault, but are also at increased risk of unintentional injuries, such as falls or motor vehicle collisions. [83,101] The secondary objective of Study 2 was to examine the relationship of post-index MHA service utilization to hand and wrist trauma. Hard matching on this variable enabled a stratified analysis based on pre-index MHA utilization with the outcome of post-index MHA service utilization attributable to hand and

wrist trauma.

Propensity scores are characteristically for predicting the probability of receipt of a particular treatment. A set of covariates are used to generate the propensity score for each subject using a logistic regression to model the probability of receiving the specified treatment.[65] In our study, propensity scores were used to predict the probability of having an episode of hand and wrist trauma using the entire sample of cases and potential controls, rather than receiving a specific treatment. Propensity scores can be used to reduce confounding in a number of ways: regression adjustment (i.e. using the PS as a covariate in a regression model), stratification (i.e. stratification by quantiles of PS), inverse probability weight using the propensity score, or matching.[102] Matching was used in this study.

Covariates for the propensity score match emphasized the socioeconomic factors that appear to be influential in sustaining hand and wrist trauma. These covariates included in the logistic regression were the LHIN in which the patient resided, the 2008 Rurality Index of Ontario (a measure of rurality that consists of three weighted components [population based on postal code and travel times to both basic and advanced referral centres], ranging from zero [major urban] to 100 [rural]),[103] Comorbidities listed on outpatient and hospital discharge abstracts 1 year pre-index date were categorized according to collapsed aggregated diagnosis groups [104], the Ontario Marginalization Index (an area-based index that shows differences in inequalities between population groups or between geographical areas),[105] and an estimate of the household income quintile at the neighbourhood level (based on postal code and Canadian census data).[106,107]

The matching algorithm was index event (month and year), sex, age at index (± 1 year), and the logit of the propensity score using nearest neighbor matching, with the allowance of a 0.2 standard deviation caliper width of the logit of the propensity score.[108] Balance between cases and controls was assessed for each variable included in the propensity score, with standardized

differences of less than 0.1 indicating good balance.[65]

The primary outcome of this study was the 3 year attributable costs of isolated hand and wrist trauma. A validated algorithm developed for Ontario population health administrative data was used to estimate resource utilization and to compute individual-level health care costs over a three-year period following the index date.[47109] All costs were adjusted to 2014 Canadian dollars using the healthcare component of the Consumer Price Index.[110] Medical costs were estimated for each case and matched controls during the fiscal years of the observation period. Because controls were matched to cases in a 4:1 manner (Table 2.2), the costs for each of the controls were weighted appropriately and summed in order to create an average representing one individual. The attributable costs following surgical hand and wrist trauma were then isolated using a difference-in-differences approach. Baseline health care costs accrued in the year prior to the hand and wrist trauma (cases) or assigned index date (control) were subtracted from the costs in the first, second and third year health care costs. The first difference (cases) was then compared to the second difference (controls) (Figure 2.2)[111,112].

Costs were categorized as acute care hospital costs(emergency department, index admission, rehabilitation and any subsequent readmissions within the first 30 days following index); physician services costs; drugs and laboratory costs outside of hospitals; continuing care (residential long-term care and home care); and assistive devices costs [113,114]. The sources of potential short and long term health care costs are outlined in Table 2.2. Health care utilization following the index hand and wrist trauma was summarized based on encounters with the health care system for hospitalizations, ED visits, family physician visits, and same day surgery admissions. Mental health and addiction services utilization was identified using a validated algorithm [72] and characterized as a dichotomous variable.

2.6 Covariate Collection

Patient demographic data included age at index date and sex. Geographic data included the LHIN, rurality and estimated income quintile based on postal code. Rurality was measured using the Rurality Index of Ontario (RIO2008), which utilizes the postal code to designate a rurality score with 0-10 representing Major Urban, 11-40 representing Urban and 41-100 representing Rural.[103] The Ontario Marginalization (ON-Marg) Index was also assessed. The ON- Marg is an area-based index that seeks to show differences in marginalization between geographic areas. This index incorporates multiple dimensions of marginalization including residential instability, material deprivation, dependency and ethnic concentration.[115] In this study, the ON-Marg summary score was used which is a summation of the quintile score for the four dimensions divided by a factor of four producing a score ranging from one to five. A score of one reflects low levels of marginalization and five reflects high levels of marginalization. The chosen measure of comorbidity status for this study was the John Hopkins adjusted clinical groups system (ACG). This measure was chosen because it was designed for use in an ambulatory population and hand and wrist trauma patients, most often, are treated on an ambulatory basis. Further the ACG was created to predict healthcare utilization, which is an important factor for close matching of cases and controls.[116,117]

Injury related variables were defined based on the ICD-10 diagnoses. The primary diagnosis defined the injury type, which were classified as *Amputation, Burn, Crush/mangle, Dislocation, Fracture, Ligamentous Injury, Nerve Injury, Tendon Injury, Vascular Injury, Open Wound, Other Musculoskeletal Injury, Unspecified Upper Extremity Injury (*Appendix 2.4*).* The primary diagnosis also allowed delineation of injury in the following manor: Finger, Hand/wrist, Forearm, Elbow, Arm, Shoulder, Multi-level, Unspecified (Appendix 2.5). Mechanism of injury can be specified in ICD-10 diagnostic fields 2-10 and allowed for the classification of the mechanism of injury: Blunt trauma, Cycling Injury, Motor Vehicle Collision, All Land Transport, Machinery, Laceration, Fall, Missing and Other.

Comorbid diagnoses included workplace-related injuries and comorbid mental health issues. A variable was created for comorbid mental health and addiction diagnoses based on the presence of a secondary ICD-10 diagnosis of a mental health or addiction/substance use disorder. Workplace injury was also identified based on a secondary diagnosis of a work-related injury based on ICD-10 codes.

2.7 Data Analysis

2.7.1 Study 1: Epidemiology of Adult Isolated Hand, Wrist and Upper Extremity Peripheral Nerve Trauma in Ontario

Descriptive statistics of demographic, injury and utilization characteristics of all hand and wrist trauma patients was performed. The absolute number of episodes of hand and wrist trauma presenting to the ED were then translated into an incidence rate (per 10,000) by annum using Ontario population data and stratified by sex for individuals 18-65 years of age (Appendix 2.5). The annual incidence of repeated hand and wrist trauma was calculated among the accrued population of index hand and wrist trauma patients. An incidence risk ratio with 95% confidence intervals was used to compare the risk of having a repeated episode to having an index episode of hand and wrist trauma. Incidence was also calculated for each LHIN using annual population data. LHINs were compared to designated manufacturing regions of Ontario[118] in order to identify the LHINs that have a greater incidence of manufacturing and construction employment. We also evaluated temporal trends in total number of hand and wrist trauma episodes and fracture episodes by month, stratified by gender. Comparisons between temporal trends of hand and wrist trauma by sex were performed by calculating a Pearson correlation coefficient. Pearson correlation was also performed between LHIN population and annual incidence of hand and wrist trauma. Analysis of Variance (ANOVA) was utilized to evaluate differences in average hand and wrist trauma incidence between income quintiles. Mean and median time to discharge were calculated for all hand and

wrist trauma episodes and further stratified by procedure types. Comparative analyses were performed by stratifying the population by sex, age category, surgical hand and wrist trauma, repeated hand and wrist trauma and prior mental health utilization using independent sample *t* tests for continuous variables and χ^2 tests for categorical variables. All statistical analyses were performed using SAS software (SAS version 9.3 and SAS Enter- prise Guide version 6.1; SAS Institute).

2.7.2 Study 2: Attributable Long Term Costs Following Hand and Wrist Trauma

The quality of the match of cases to controls was evaluated as previously described. Attributable cumulative costs were calculated by comparing the total attributable cost between the propensity-score matched pairs of controls and cases over 1-, 2- and 3-year periods following the index event**.** Attributable costs were described in relation to specific health care sector costs including inpatient, outpatient, and emergency department care, primary care and specialist service fees. The means of cost differences by age category, sex, surgery type, injury type, pre-index mental health utilization, post-index mental health utilization were calculated and compared. Utilization was categorized based on frequency of visits (dichotomous variables): ≥1 hospitalization, ≥2 hospitalizations, ≥2 SDS episodes, ≥3 ED episodes, ≥5 family physician visits, any MHA service utilization. Categorical variables were compared using independent sample *t* tests for continuous variables and χ^2 tests were used for categorical variables. For matched data, categorical and continuous variables were compared using McNemar's test and paired t-test to account for the paired nature of the data.

2.8 Data Management and Ethics

All data for Study 1 and Study 2 were housed at the Institute for Clinical Evaluative Sciences (www.ices.on.ca/) in Toronto, Canada. Unique encoded identifiers for individual records in the

datasets were linked across databases. Records were anonymized before analysis and cells with fewer than 6 individuals contributing are reported as ≤ 5 for patient confidentiality. The study was approved by research ethics boards at Sunnybrook Health Sciences Centre. Privacy Impact Assessment approval was granted from the Institute for Clinical and Evaluative Sciences (Toronto, Canada). A copy of this approval is located in Appendix 2.6.

2.9 Tables

Table 2.1: Summary of databases accessed for both Study 1 and Study 2, including a description of the database, the key variables accessible and validation studies

Database	Setting	Description	Key Variables	Comprehensiveness and Validity
Ontario Registered Persons Database (RPDB)[119]	General Population	The RPDB contains vital statistics of all OHIP eligible Ontario residents.	Demographic Variables • Eligibility for health benefits • Date of death	• Captures all Ontario residents registered under OHIP. • RPDB is updated every 2 months through linkage to other databases • May not capture people moving outside of ON[120]
Discharge Abstract Database (DAD)[121]	Acute Inpatient Hospitalizations	The CIHI DAD is a National database that contains demographic, diagnostic, clinical, and administrative data for inpatient hospital admissions. It contains over 1 million inpatient abstracts from 178 acute care facilities in Ontario.[120]	• ICD-10-CA • CCI* and CCP† • LOS • Facility transfer • Resource Intensity Weight	• Nearly 85% in re-abstraction study for most responsible diagnosis code. • 98% code agreement in re-abstraction study for CCI code match • 100% agreement for non-medical data elements (demographics, LOS, admit date)
National Ambulatory Care Reporting System (NACRS)[122]	Emergency, Day Surgery, and high-cost ambulatory treatments	The NACRS is a national databased designed to capture information for all ambulatory care including emergency department visits, outpatient clinics, and day surgery.	• ICD-10-CA • CCI and CCP • Resource Intensity Weight • Facility transfer • ED Triage Information	In reabstraction and inter-rater reliability studies, agreement rates in the selection of main problem was >85%, and >73% for reason for visit.[95] 191 facilities in ON reporting >10mllion visits [122]
Ontario Health Insurance Plan (OHIP)	Outpatient and Physician Services	OHIP data cover all service and procedure claims by healthcare providers (physicians, diagnostic	• Date of service	• Fee for service used by approximately 95% of Ontario physicians[94] alternative funding plans primarily using shadow

		imaging, laboratory services).	• Fee Code • Fee Paid	billing.
Ontario Mental Health Reporting System (OMHRS)	Mental Health	The OMHRS was created in 2005 to evaluate persons in mental health (MH) beds using the Minimum Data Set for MH (MDS-MH) on admission, discharge, or at 92 day intervals for longer admissions. A Case Mix Index (CMI) is assigned for each episode approximating the per day resource use and can be adjusted multiple times.	• Admission Date • Discharge Date • Case Mix Index • Assessment Date • RIW	• Inter-rater reliability with kappa value >40% for nearly all items on RAI-MH[123]* with only 15% of items with kappas <60%[124]
National Rehabilitation Reporting System (NRS)	Rehabilitation	The NRS contains National data on rehabilitation facilities and clients, collected from participating adult inpatient rehabilitation facilities and programs.	• Admission Date • Discharge Date • Resource Intensity Weight	All eligible Ontario facilities are included; 100% response rate. Missing discharge record in 2.2% of Ontario visits.[125]
Continuing Care Reporting System (CCRS)	Complex Continuing Care	CCRS captures clinical and demographic information for patients receiving facility based continuing care.	• Admission Date • Discharge Date • Case mix index • RIW	• 80% sensitivity in 70% of most common acute care primary diagnoses; however, some diagnoses have low sensitivity[126]
Ontario Home Care Administrative System (OHCAS) and Home Care Database (HCD)	Home Care	The OHCAS and HCD capture data on services provided to those through Ontario's Community Care Access Centres (CCAC)[127]. The HCD replaced the OHCAS in 2005/2006 fiscal year	• Services Provided • Admission/ discharge date	• All CCAC sites are represented. • Incomplete capture of data due to invalid OHIP status in some clients (e.g. clients with no fixed address) • Variable data completeness by region

Ontario Drug Benefit (ODB)	Prescription Drugs	The ODB includes drugs dispensed in community pharmacies and LTC/nursing facilities and covers all seniors in Ontario (aged 65+) and those on social assistance for all prescriptions listed in the provincial formulary.	• Drug Identification Number (DIN) • Fee Paid by Ministry of Health • Long Term Care Indicator	• Second largest prescription database in Canada. • At least 95% of seniors filled 1 Rx in ODB over a 5 year period; however 15-20% filled a Rx from a private insurer.[128] • High coding reliability, overall error rate of 0.7% (95% CI 0.5%-0.9%).[129] • Drugs dispensed during acute hospitalizations are not captured.

Table 2.2: Resources provided and funded within the provincial health system in Ontario
• Inpatient hospitalizations • Outpatient visits • Emergency room visits • Investigations (imaging, laboratory, etc.) • Medications (only in individuals with access to the ODB program) • Physician services (specialist/Family physician) • SDS and other ambulatory treatments • Home care, complex continuing care and long term care • Adaptive devices (e.g. Prosthetics, through the Adaptive Devices Program) • MHA service utilization

2.10 Figures

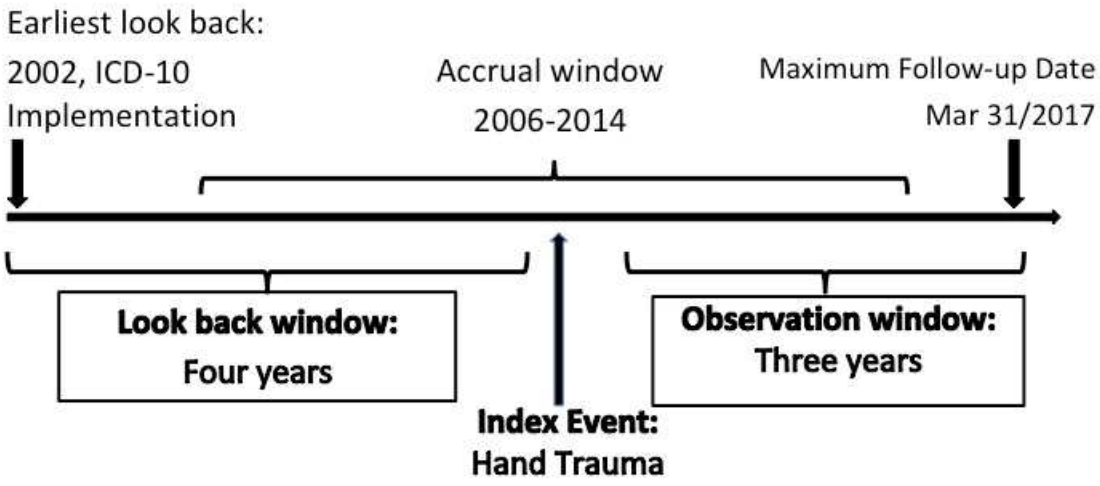

Figure 2.1 Schematic representation of the look back, accrual and observation periods for cases and controls relative to the index hand and wrist trauma event (cases) or randomly assigned index date (controls). Cases and controls were excluded if there was an episode of hand and wrist trauma in the four year look back window. Controls were excluded if there was an episode of hand and wrist trauma in the three year observation window. The accrual window extended for the 2006-2014 fiscal years to enable 3 years of observation window extending until March 31, 2017.

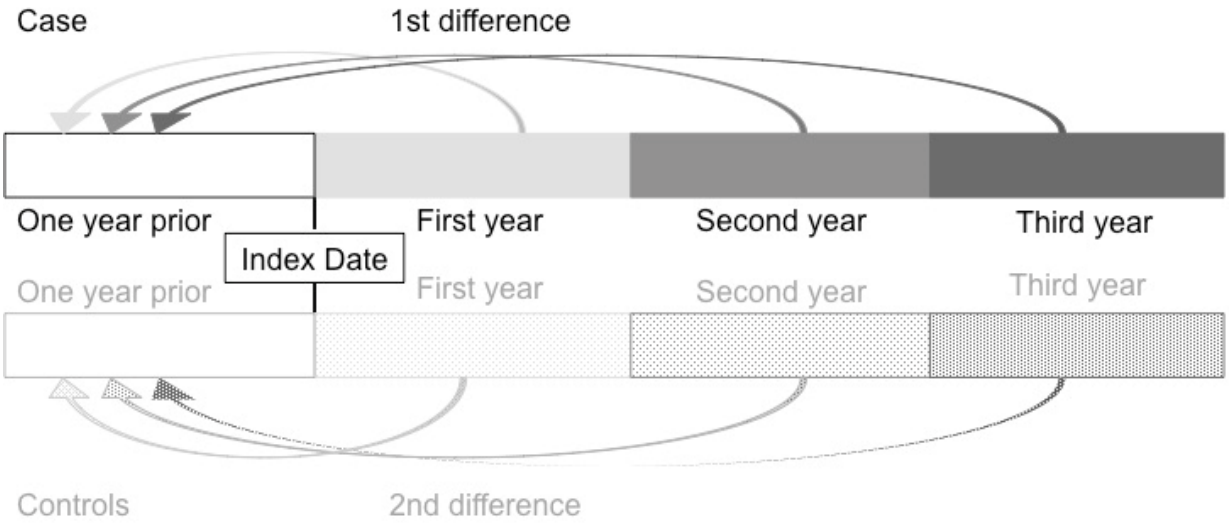

Figure 2.2: Schematic representation of the attributable cost calculation. For each isolated adult hand and wrist trauma case, four controls without hand and wrist trauma were identified based on matching and propensity score. Pre-index total health care costs were estimated and subtracted from one, two and three year costs for cases (first difference) and controls (second difference). The control costs were weighted according to the number of matches per case. The second difference was compared to the first difference to attain the attributable health care costs arrising from isolated hand and wrist trauma among adults.

Chapter 3: Results of Study 1: Epidemiology of Adult Hand, Wrist and Upper Extremity Peripheral Nerve Trauma In Ontario

3.1 Inception Cohort: All Episodes of Isolated Adult Hand, Wrist and Upper Extremity Peripheral Nerve Trauma

Figure 3.1 demonstrates the iterative process to identify the study cohort, based on the inclusion and exclusion criteria. The total number of adult patients with these isolated upper extremity traumas seen in Ontario ED's between April 1, 2006 and March 30 2016 was 2,045,950.

3.2 Annual Incidence and Overall Volume of Isoated Hand, Wrist and Nerve Trauma Among Adults in Ontario

The absolute volume of episodes of isolated hand, wrist and nerve trauma among adults in Ontario is depicted in Figure 3.2. Among all Ontarians, there was a decrease in the volume of hand, wrist and nerve trauma between 2006-2009 followed by a slight increase. Males had approximately twice the volume of hand, wrist and nerve trauma annually between 2006-2009. Following 2009, volumes of hand, wrist and nerve traumas in men remained relatively stable, while there was a gradual increase in hand, wrist and nerve trauma among women.

Figure 3.3 depicts the annual incidence of adult isolated hand, wrist and nerve trauma in Ontario. The average incidence over a 10-year interval (2006-2016) was 211/10,000 persons. The average annual incidence for males and females was 269/10,000 and 157/10,000 persons, respectively. Temporal trends varied between males and females with an overall correlation coefficient of $r = 0.52$ ($p = 0.13$). Both sexes demonstrated an initial decline in annual hand, wrist

and nerve trauma incidence between 2006-2009 (r = 0.95; p = 0.01), yet following 2009, temporal trends of hand, wrist and nerve trauma incidence differed between sexes with female incidence slightly increasing and male incidence remaining relatively stable (r = -0.59; p = 0.12).

3.3 Demographics of the Adult Hand, Wrist and Nerve Trauma Cohort

Table 3.1 provides a summary of the demographic features of the adult hand, wrist and nerve trauma cohort. The average age at presentation is 38.9 +/- 13 years with males generating 62.6% of the episodes. Episodes of hand, wrist and nerve trauma were most common in males in the youngest age category and females in the oldest age category (Males 18-30 years: 35% of all males; Females 51-65 years: 32% of all females; $p < 0.001$). Figure 3.4 demonstrates the difference in trends when volume of hand, wrist and nerve trauma is examined based on sex and age category. The majority of hand, wrist and nerve trauma (65%) episodes occurred in major urban centres. Lower income quintiles represented a greater proportion of hand, wrist and nerve trauma episodes with 21.88% and 17.88% of episodes occurred among subjects identified as income quintile 1 and 5, respectively.

3.4 Injury Characteristics of Hand, Wrist and Nerve Trauma

Injury characteristics for the cohort are outlined in Table 3.2. Approximately 28 percent of hand, wrist and nerve trauma episodes are Canadian Trauma Acuity Score (CTAS) 1-3, indicating either urgent, emergent or resuscitation levels of ED care. The ICD-10 mechanism of injury demonstrated that cut/pierce-types of injuries were the most common (33.2%), followed by falls (17.4%) and blunt injury/crush (12.9%). Mechanism of injury was missing in approximately 17% of episodes. Firearm and machinery related injuries comprised a small proportion of the index hand, wrist and nerve traumas (0.05% and 2.99%, respectively). Injuries were identified as work-related based on secondary ICD-10 diagnostic codes in 6.4% of episodes, but the accuracy of this

diagnostic code has not been determined. Open wounds (including complex, deep and superficial) were the most common primary diagnosis representing 55.3% of index hand, wrist and nerve traumas, followed by fractures (20.3%). Severe injuries, including crush, avulsion and amputation injuries, represented 2.5% of hand, wrist and nerve trauma episodes; however, this equates to 50,257 episodes over 11 years, or just under 5,000 devastating hand injuries per year in Ontario.

3.5 Hand, Wrist and Nerve Trauma Comparison Between Sexes

Univariate comparisons of covariates by sex (Appendix 3.1) demonstrated that women with hand, wrist and nerve trauma were more likely to fall into the 51-65 age category (Female: 32%, Male: 22%; $p<0.001$) and males in the 18-30 age category (Female 27%, Male: 35%; $p<0.001$). Females were more likely to have accessed services for mental health and addiction issues in the year prior to the index hand, wrist and nerve trauma (OR 1.83; 95% CI: 1.82-1.84 $p<0.001$). Women were less likely to have a workplace injury (OR 0.61; 95% CI: 0.6-0.61); $p<0.001$). Injury type differed between sexes; compared to females, males were more likely to sustain open wounds (58.5% vs 49.9%, $p<0.001$) and less likely to sustain burns (2.4% vs 4.1%, $p<0.001$) and ligamentous injuries (4.8% vs 7.8%, $p<0.001$). Female episodes of hand, wrist and nerve trauma occurred more commonly at the level of the hand and wrist (51.8% vs 44.8%, $p<0.001$), while fingers were more commonly injured in men (43.7% vs 35.6, $p<0.001$). The mechanism of injury also differed between sexes: hand, wrist and nerve trauma secondary to falls was more common in females (25.8% vs 12.4%, $p<0.001$), while hand, wrist and nerve trauma secondary to lacerations (36.3% vs 28.1%, $p<0.001$), blunt trauma (14.7% vs 9.7%, $p<0.001$) or machinery-related injuries (4.2% vs 1.0%, $p<0.001$) was more common in males.

Temporal trends by month indicate a clear relationship to the season, with the volume of hand, wrist and nerve trauma increasing in the June – September months. This seasonal fluctuation is particularly prominent among males, while the seasonal variation in hand, wrist and nerve

trauma volume is not as prominent among females in the summer months and appears to have an annual increase in the winter months (Figure 3.5). Figure 3.6 depicts the seasonal trends in the Ontario population by sex for fracture volumes demonstrating increased volumes of fractures among men and women in the summer months and winter months, respectively.

3.6 Hand, Wrist and Nerve Trauma and Socioeconomic Status

When the cohort was stratified by income quintile, the lowest income quintile had the greatest annual incidence of hand, wrist and nerve trauma (231/10,000 person) while the highest income quintile had the lowest annual incidence (186.8/10,000 persons) with a significant difference between the five quintiles (F=27.4, p<0.0001)(Figure 3.7&3.8). The majority of episodes occurred in a major urban setting (61.4%) and the minority in a rural setting (12.1%); however, the annual incidence was greater in less populated LHINs (Table 3.3). Figure 3.9 demonstrates wide variation in incidence of hand, wrist and nerve trauma by LHIN where 7 LHINs demonstrated hand, wrist and nerve trauma incidence greater than the provincial incidence. These 7 LHINs were more rural and some were more likely to have manufacturing hubs. There was a negative correlation between LHINs with lower populations and the average incidence of hand, wrist and nerve trauma between 2006-2016 (Figure 3.10) (R = - 0.74, p = 0.002).

Twenty-one percent of hand, wrist and nerve trauma episodes occurred in subjects who accessed MHA in the year prior to the index hand, wrist and nerve trauma. Hand, wrist and nerve trauma patients with pre-injury utilization of MHA services were more likely to be female (48.9% vs 34.3%; sd 0.3; p <0.001), to live in regions associated with the lowest income quintile (25.6% v. 20.7%; p<0.001), had greater Ontario Marginalization Summary scores (3.14 vs. 3.01; p<0.001) and were more likely to have repeated episodes of hand, wrist and nerve trauma (30.3% vs 23.4; p < 0.001) (Appendix 3.2).

3.7 Health Care Utilization Following Hand, Wrist and Nerve Trauma

Table 3.2 summarizes health care utilization following hand, wrist and nerve trauma. As outlined in Table 3.2 and Figure 3.11, of the 2,045,950 episodes of isolated hand, wrist and nerve trauma, there were 1,538,123 individual patients among whom there were 507,395 repeated episodes (24.8% of all episodes) in the 2006-2016 interval . Of the patients with repeated hand, wrist and nerve trauma (n = 345,708), 75% had two episodes, and 98,440 had 3 or more visits for isolated hand, wrist and nerve trauma (Figure 3.8). Further, approximately 2.9% of episodes (n= 58,754) were within 30 days of a previous episode with the same diagnostic code. Figure 3.12 depicts the temporal trend in first or "index" hand, wrist and nerve trauma visits, repeated visits and repeated visits for the same diagnosis within 30 days. The annual incidence of hand, wrist and nerve trauma was over three times greater in subjects that had a prior hand, wrist and nerve trauma episode than index events (576 repeated hand, wrist and nerve trauma episodes annually/10,000 index hand, wrist and nerve trauma subjects vs 159 index hand, wrist and nerve traumas /10,000 persons; IRR 3.6, 95% C.I. 3.4-3.8, $p<0.001$). While index episodes have a declining trend, repeated episodes are increasing with time as the cumulative pool of index hand, wrist and nerve trauma patient grows.

Repeated episodes of hand, wrist and nerve trauma were more likely to be in males (OR: 1.4; 95% CI: 1.39-1.41; $p < 0.001$), occur in patients living in urban (OR: 1.23; 95% CI: 1.24-1.25; $p < 0.001$) and rural areas (OR: 1.4; 95% CI: 1.4-1.43; $p < 0.001$) and less likely to occur in patients living in major urban areas (OR: 0.7; 95% CI: 0.7-0.71; $p < 0.001$). Subjects who had accessed MHA services in the year prior to index hand, wrist and nerve trauma were more likely to have repeated hand, wrist and nerve trauma episodes then subjects that have not access MHA services (OR: 1.42; 95% CI: 1.41-1.43; $p < 0.001$) (Appendix 3.3)

Pre-hospital transport was required for 3.8% of episodes (n=77,562) with ground transport representing the most common form of transport (99.8%). Interhospital transfers occurred in 1.4% of episodes (n = 28,272) for either ER management (n=12,726) or, more commonly, admission (n=15,546). Procedural intervention was necessary in 35% (n=715,308) of the hand, wrist and nerve trauma episodes and the majority of these procedures took place in the emergency department (n = 661,300). The average annual incidence of emergency department procedures was 68.2/10,000 with a decreasing trend over the study period (Figure 3.10). 54,008 episodes of hand, wrist and nerve trauma required urgent or emergent surgery. Acute surgical admission was less common (n=15,337) than outpatient ambulatory surgery (n = 38,671). The mean annual incidence of all surgical hand, wrist and nerve trauma was 5.57/10,000 persons. Over the duration of the study period, there was a decline in the incidence of acute admission for surgery and an increase in the incidence of ambulatory surgery (Figure 3.13). The median length of stay for an episode of hand, wrist and nerve trauma was 1 day, with <1% (n=15,307) of episodes requiring a length of stay of 2 or more days.

Episodes of hand, wrist and nerve trauma requiring surgery (SDS or inpatient) occurred in patients that were older (average age 41.3 ± 13.4 vs 38.8 ± 13.4; $p < 0.001$). Surgical hand, wrist and nerve trauma was associated with emergent/urgent CTAS classification in 61.9% of episodes ($p<0.001$). Specific injury types were associated with surgical interventions including amputation ($p<0.001$), nerve injury ($p<0.001$), tendon injury ($p<0.001$) and fracture fixation ($p<0.001$). Injuries at the level of the forearm and finger were associated with surgical procedures ($p<0.001$) (Appendix 3.4).

Emergency department wait times were available for only 9.3% (n = 190,423) of all hand, wrist and nerve trauma episodes. Table 3.4 summarizes the time from triage to discharge for all hand, wrist and nerve trauma episodes, episodes requiring a procedure in the ED, episodes

requiring SDS and episodes requiring acute admission for surgery. Time to discharge was greater in patients requiring SDS or acute surgical admission. Ten percent of episodes requiring a procedure in the ED and 25 percent of episodes requiring a SDS procedure utilized >4 hours of time in the ED; the recommended time to discharge for non-admitted patients is 4 hours and 8 hours for admitted patients in Ontario. Ten percent of episodes that resulted in admission to hospital spent >8 hours in the ED.

3.8 Tables

Table 3.1 Overall demographic characteristics of adults with hand, wrist and nerve trauma (18-65 years; n = 2,045,950).

	Mean	SD
Age (years)	39	13.4
	n	**(%)**
Age Category (years)		
18-30	655,611	(32.04%)
31-40	426,810	(20.86%)
41-50	424,706	(20.76%)
51-65	538,823	(26.34%)
Sex		
Female	764,605	(37.37%)
Male	1,281,345	(62.63%)
Rurality		
Major Urban	1,255,144	(61.35%)
Urban	513,545	(25.10%)
Rural	246,990	(12.07%)
Income Quintile		
1st	444,909	(21.88%)
2nd	421,296	(20.72%)
3rd	404,870	(19.91%)
4th	403,014	(19.82%)
5th	359,623	(17.68%)
Mental Health and Addiction Services Utilization within a year prior to Index event		
No	1,620,476	(79.20%)
Yes	425,474	(20.80%)

Table 3.2 Injury and health service utilization-related covariates of the adult hand, wrist and nerve trauma population.

Injury-related Covariates		
	n	**(%)**
Canadian Triage and Acuity Scale (CTAS)		
Level 1	2,529	(0.12%)
Level 2	80,082	(3.92%)
Level 3	498,244	(24.37%)
Level 4	1,321,714	(64.64%)
Level 5	139,765	(6.83%)
Missing	2,615	(0.13%)
Injury Type		
Amputation	27,087	(1.32%)
Burn	61,832	(3.02%)
Crush/avulsion	23,170	(1.13%)
Dislocation	29,880	(1.46%)
Fracture	415,837	(20.33%)
Ligamentous Injury	121,891	(5.96%)
Nerve Injury	5,454	(0.27%)
Tendon Injury	31,277	(1.53%)
Vascular Injury	1,261	(0.06%)
Open Wound	1,130,935	(55.28%)
Other Musculoskeletal Injury	172,011	(8.41%)
Unspecified Upper Extremity Injury	25,243	(1.23%)
Injury Level		
Finger	832,905	(40.71%)
Hand/wrist	968,054	(47.32%)
Forearm	158,338	(7.74%)
Elbow	40,598	(1.98%)
Arm	526	(0.03%)
Shoulder	16,877	(0.82%)
Missing	7,310	(0.36%)
Unspecified level	21,270	(1.04%)
Mechanism		
Blunt trauma	262,874	(12.85%)
Fall	356,619	(17.43%)

Firearm	1,018	(0.05%)
Laceration	679,934	(33.23%)
Machinery	61,131	(2.99%)
Motor vehicle collision	26,662	(1.30%)
Cycling injury	27,682	(1.35%)
Pedestrian injury	2,637	(0.13%)
All transport	30,319	(1.48%)
Other classification	236,365	(11.55%)
Missing	347,708	(16.99%)
Work related injury (based on secondary ICD10* diagnosis)		
Yes	131,511	(6.43%)
No	1,914,439	(93.57%)
Associated acute mental health and substance abuse diagnosis		
Mental health diagnosis	3,154	(0.15%)
Substance abuse	5,839	(0.29%)

Health Service Utilization

	n	%
Recurrent hand, wrist and nerve trauma episodes	507,395	(24.80%)
Number of hand, wrist and nerve trauma episodes/patient		
1	1,192,415	(77.50%)
2	247,865	(16.11%)
3	64,849	(4.21%)
4	20,208	(1.31%)
5-10	12,786	(0.83%)
>11	480	(0.03%)
Prehospital transport	77,562	(3.79%)
Ground	77,216	(3.77%)
Air	128	(0.01%)
Combined (air/ground)	218	(0.01%)
Transfer to secondary facility	28,272	(1.38%)
For emergency room management	12,726	(0.62%)
For admission	15,546	(0.76%)
Surgical procedure		

Table 3.3: Average LHIN population and average hand, wrist and nerve trauma incidence (2006-2016).

LHIN	Average Population	Average incidence 2006-2016	95% CI
Erie St. Clair*	412,709	220.8	215.7 - 225.9
South West*	609,589	313.1	301.2 - 324.9
Waterloo Wellington	489,754	211.2	207.6 - 214.9
Hamilton Niagara*	898,019	252.1	243.9 - 260.4
Central West	562,218	157.3	152.6 - 162.0
Mississauga Halton	755,941	157.6	152.7 - 162.5
Toronto Central	808,559	177.7	174.7 - 180.7
Central	1,160,543	150.7	147.8 - 153.5
Central East	1,019,340	199.2	193.9 - 204.4
South East	314,043	304.6	297.9 - 311.4
Champlain	835,615	190.0	186.5 - 193.5
North Simcoe Muskoka	290,862	275.6	266.5 - 284.7
North East	369,384	318.5	310.1 - 326.8

North West	153,557	358.1	351.4 - 364.9

* Denotes manufacturing hub in Ontario

Table 3.4: Triage-Discharge Times in Ontario Emergency Departments Following Hand, wrist and nerve trauma

	All hand, wrist and nerve trauma	ER Procedure	SDS Procedure	Emergent Surgical Procedure	No Procedure
	N = 190,423	n = 61,038	n = 3,133	n = 1,713	n = 124,539
Mean (min) +/- SD	147 +/- 125	143 +/- 119	191+/-167	238 +/- 211	141 +/- 125
Median (min) +/- IQR	120 +/- 114	116+/- 114	154+/-148	182+/-185	114 +/- 114
Q1 (min)	1-73	1-70	1-91	1-110	1-67
Q2 (min)	73-120	71-116	92-154	111-182	68 -114
Q3 (min)	120-187	117-184	155-239	183-295	115 - 181
Q4 (min)	187-4297	185-3715	240-3073	296-1903	182 -4297
Top 90% (min)	272-4297	267-3215	350-3073	453-1903	265-4297

3.9 Figures

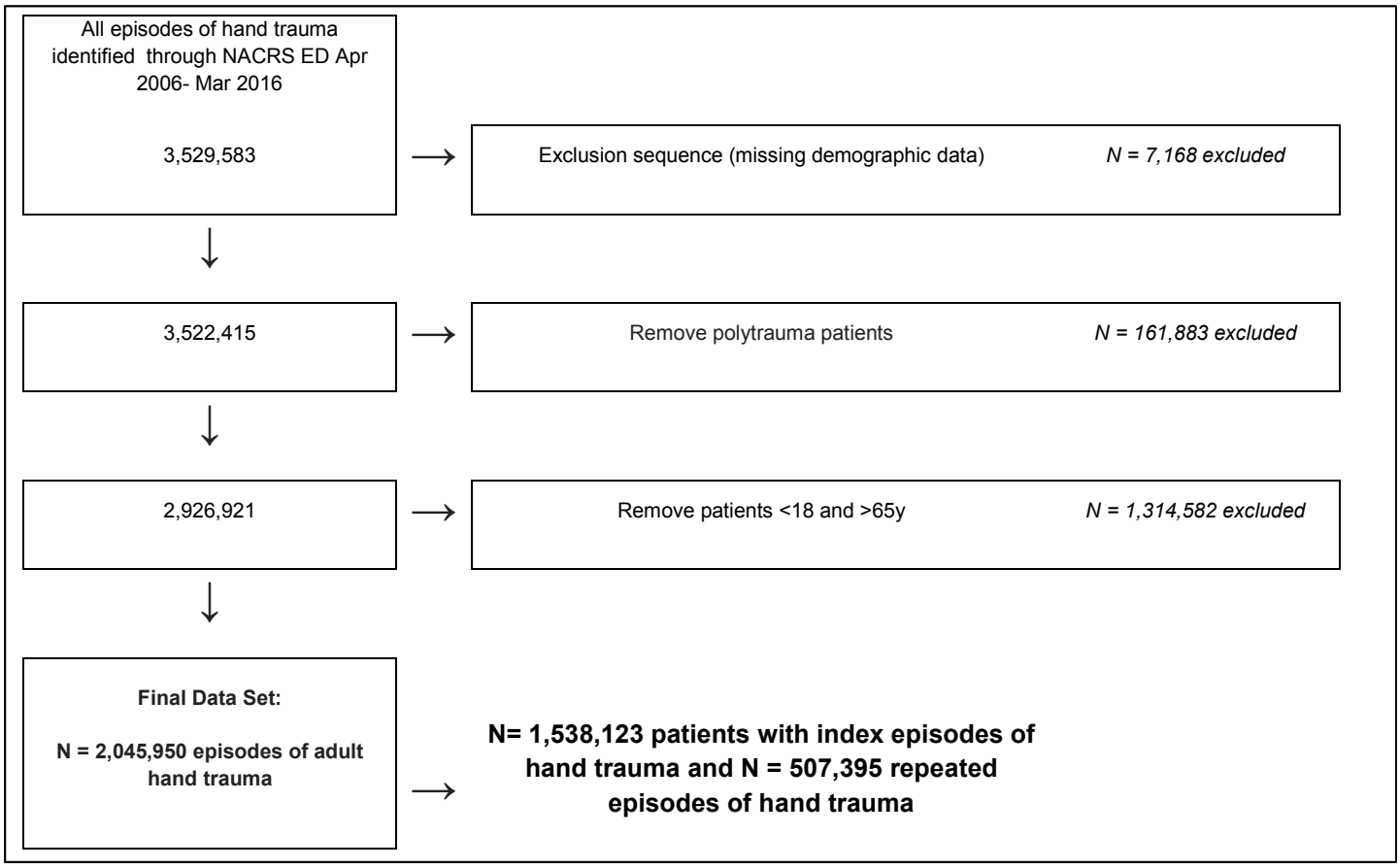

Figure 3.1: Exclusion sequence for inception cohort of hand, wrist and nerve trauma episodes in Ontario between 2006-2016.

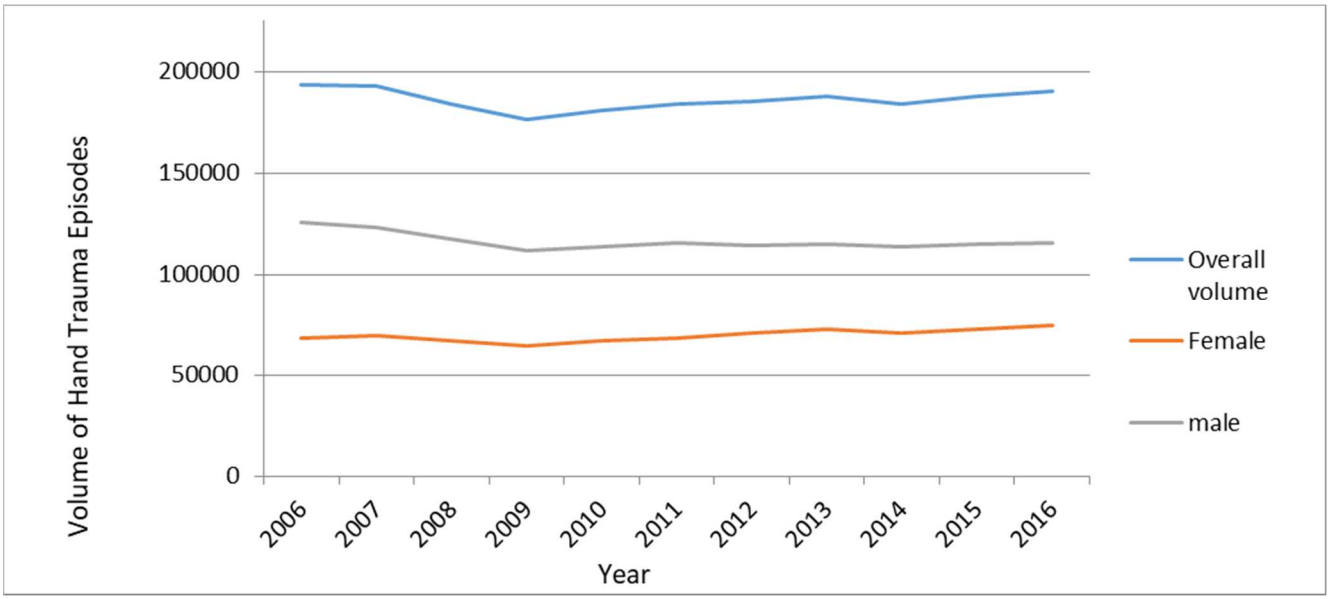

Figure 3.2: Overall, male and female volumes of all episodes of hand, wrist and nerve trauma among residents of Ontario between 2006-2016.

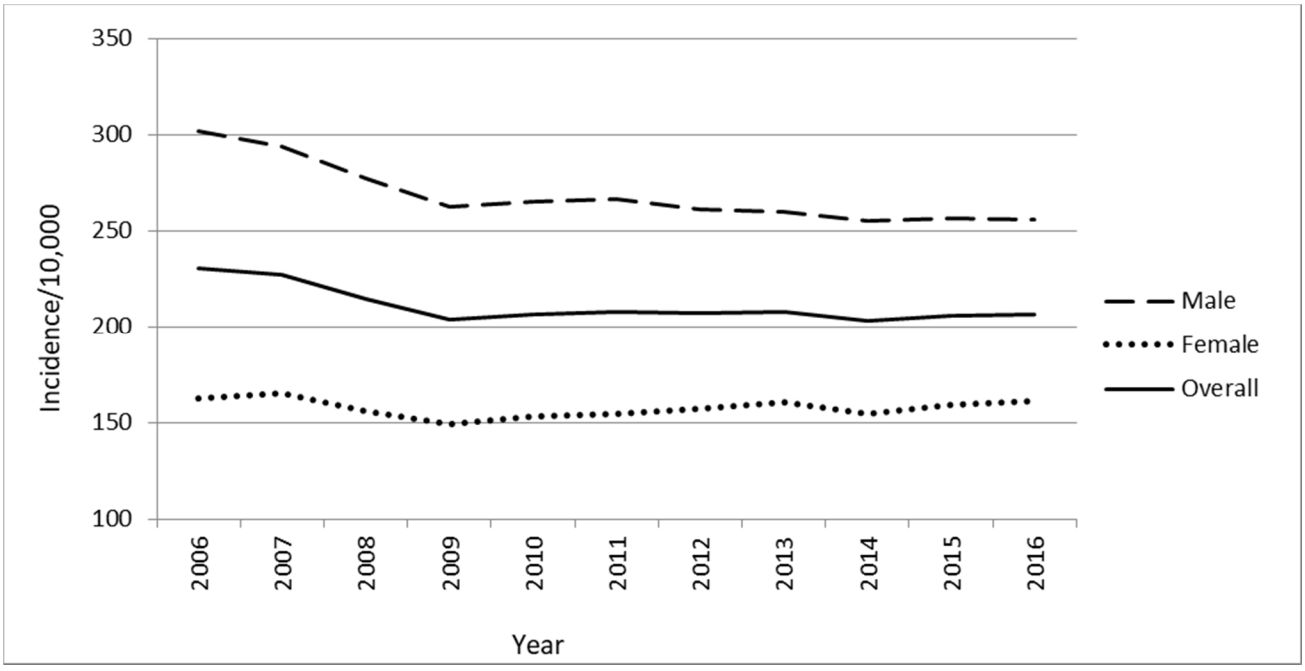

Figure 3.3 Annual incidence of all episodes of hand, wrist and nerve trauma for all Ontarians, males and females between 2006-2016.

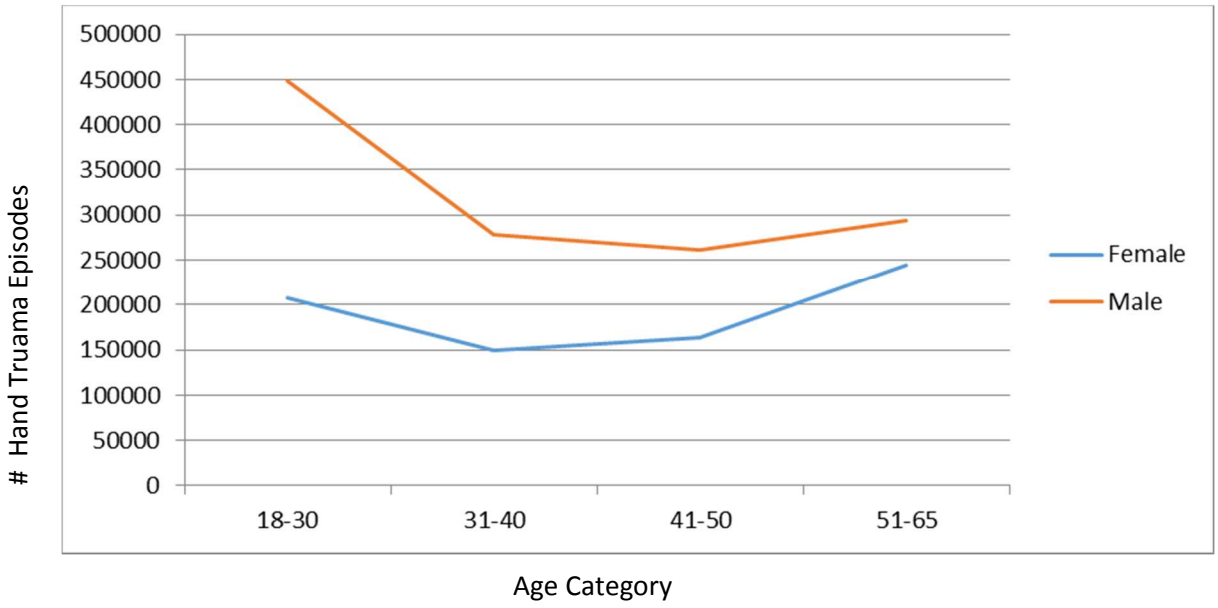

Figure 3.4 Overall volume of hand, wrist and nerve trauma stratified by age category and sex (2006-2016).

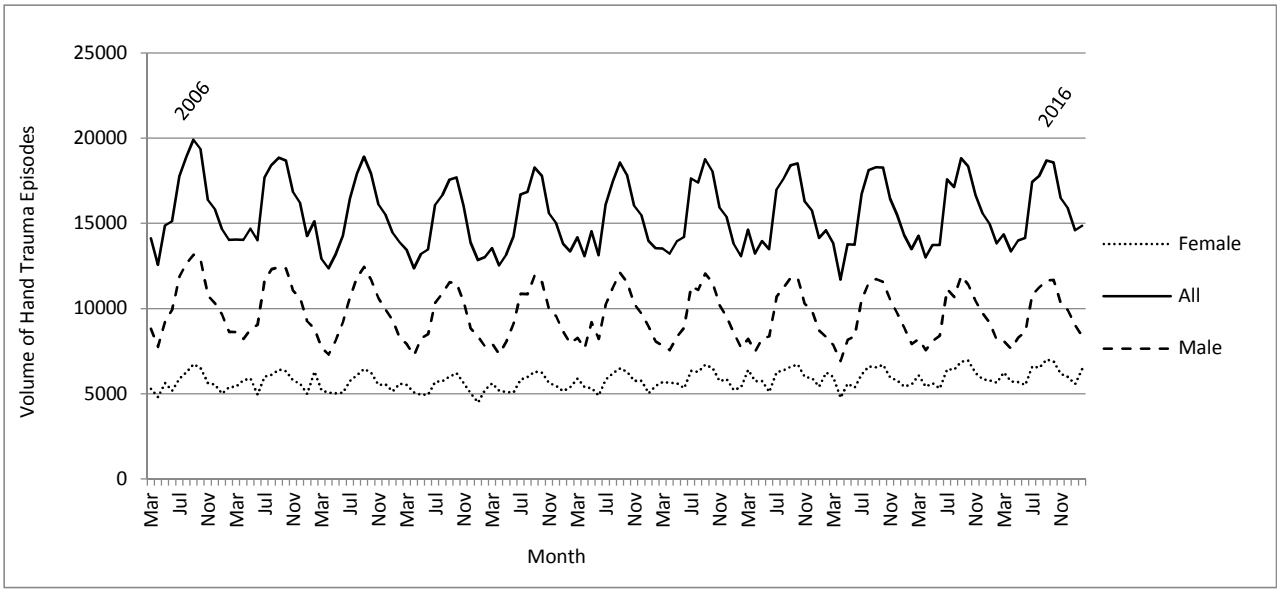

Figure 3.5: Monthly variation in adult hand, wrist and nerve trauma in Ontario overall and by sex (2006-2016).

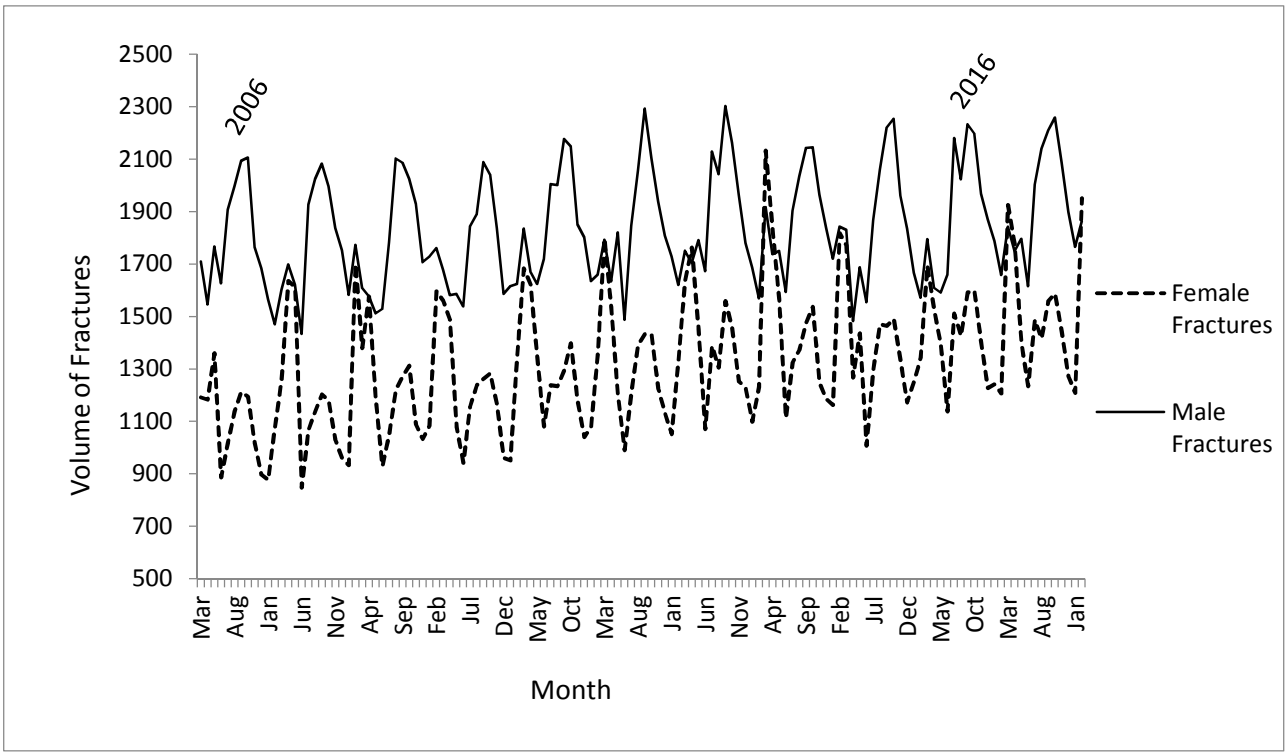

Figure 3.6: Seasonal variation in fracture volumes by sex (2006-2016).

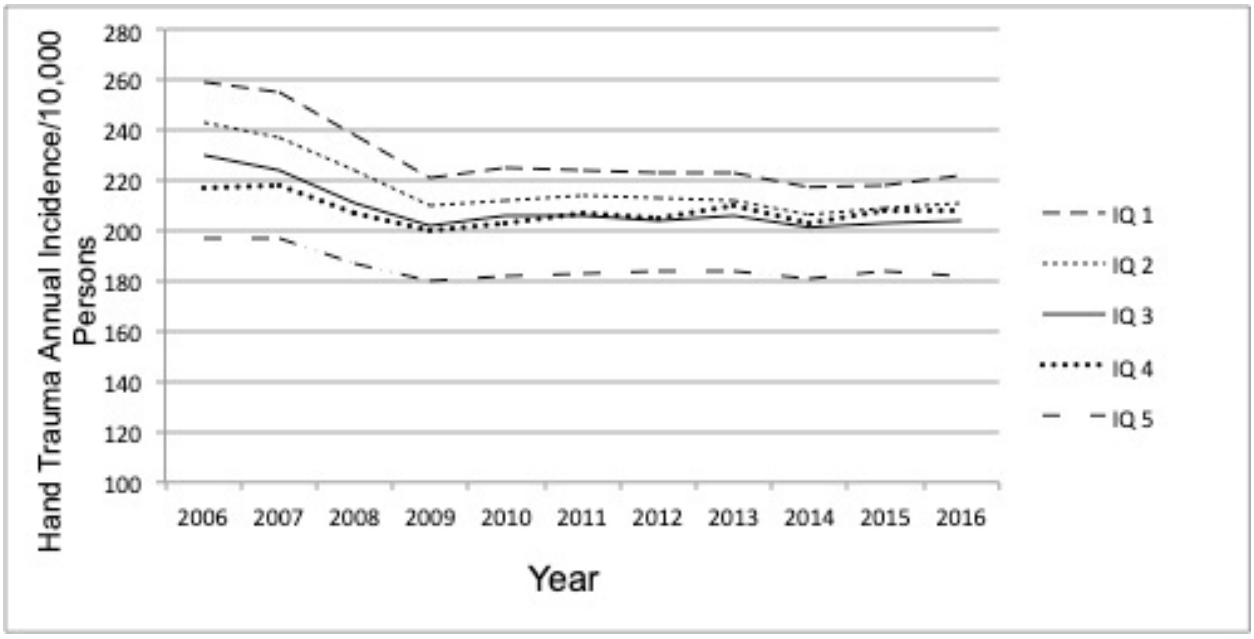

Figure 3.7: Adult hand, wrist and nerve trauma incidence by income quintile.

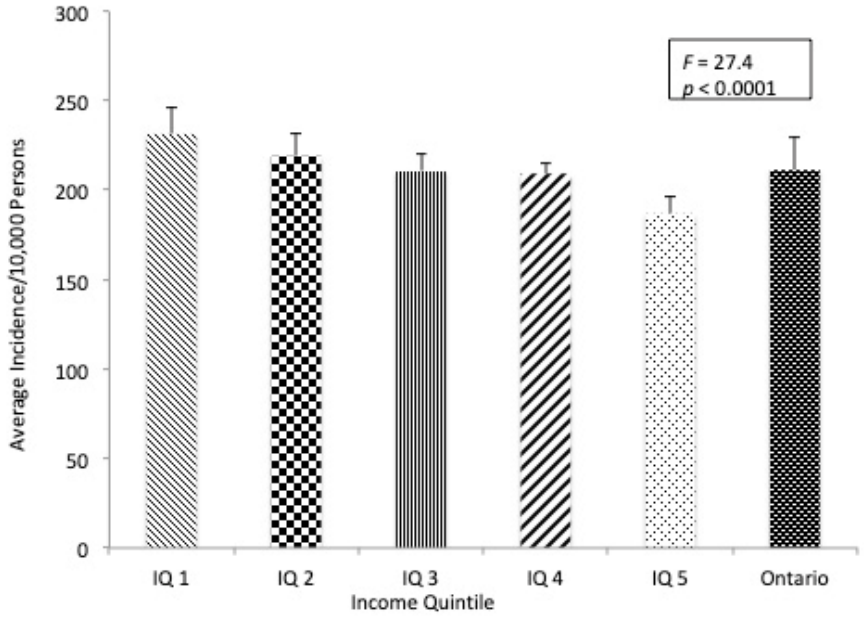

Figure 3.8: Comparison of average annual incidence by income quintile and Ontario demonstrating a significant difference in average annual incidences between income quintiles ($F = 27.4$, $p < 0.0001$)

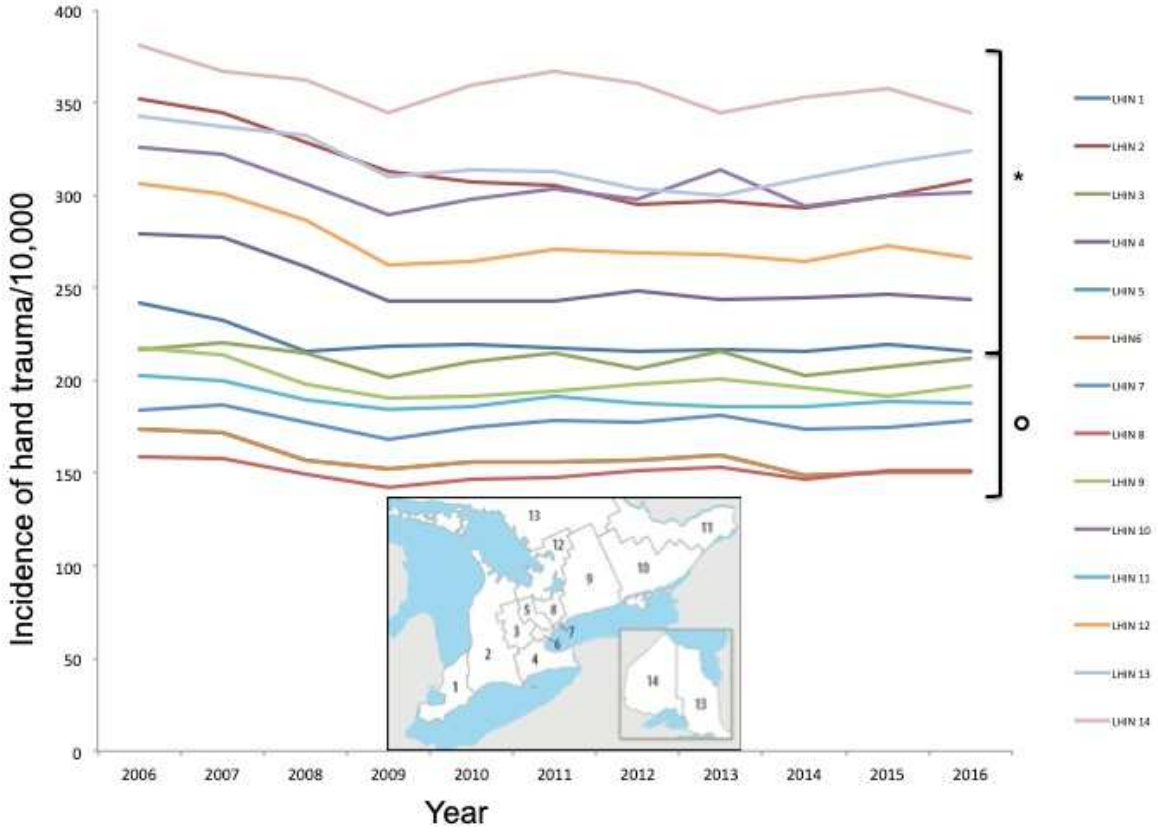

Figure 3.9: Annual incidence of hand, wrist and nerve trauma stratified by Local Health Integration Network (LHIN). The "* "denotes the LHINs with annual incidence greater than the provincial mean incidence: North East, North West, South West, South East, North Simcoe Muskoka and Hamilton Niagara Haldimand Brant. The "**O**" denotes LHINs with an annual incidence of hand, wrist and nerve trauma less than or equal to the provincial mean incidence: Erie St. Clair, Waterloo Wellington, Central East, Champlain, Toronto Central, Mississauga Halton, Central.

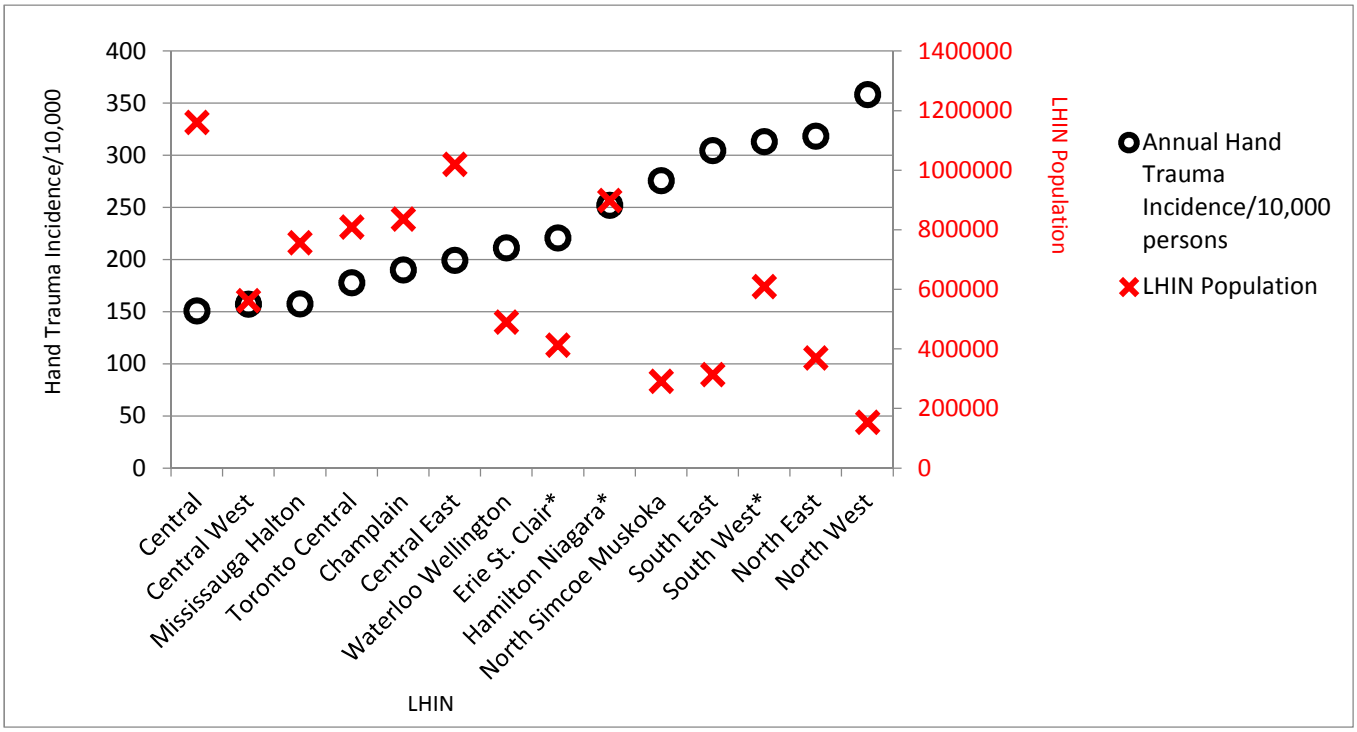

Figure 3.10: Plot demonstrating mean annual hand, wrist and nerve trauma incidence (⍰) by LHIN and average population size (X) by LHIN (2006-2016). R = -0.74, *p*=0.002.

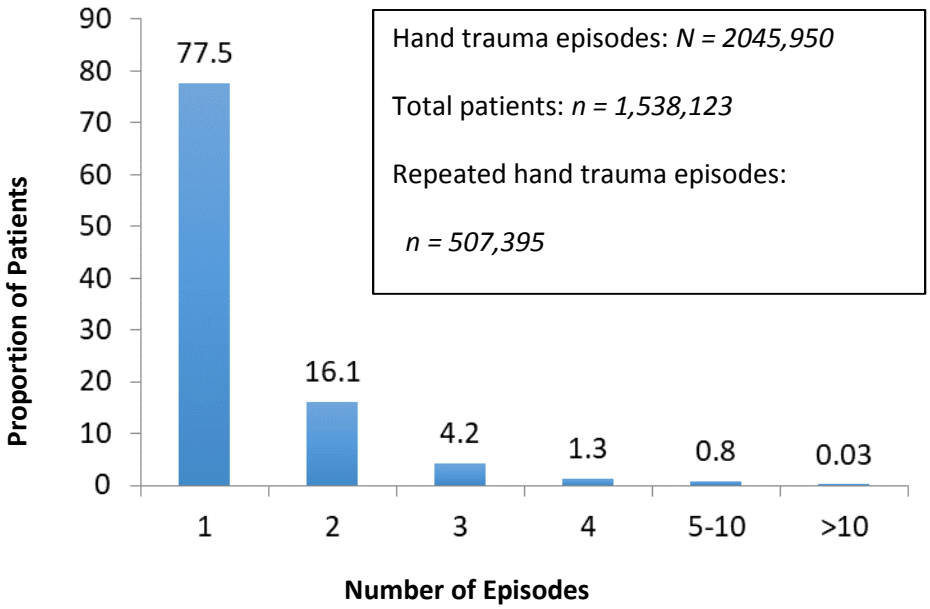

Figure 3.11: The proportion of patient presenting to the ED with only one or greater episodes of hand, wrist and nerve trauma.

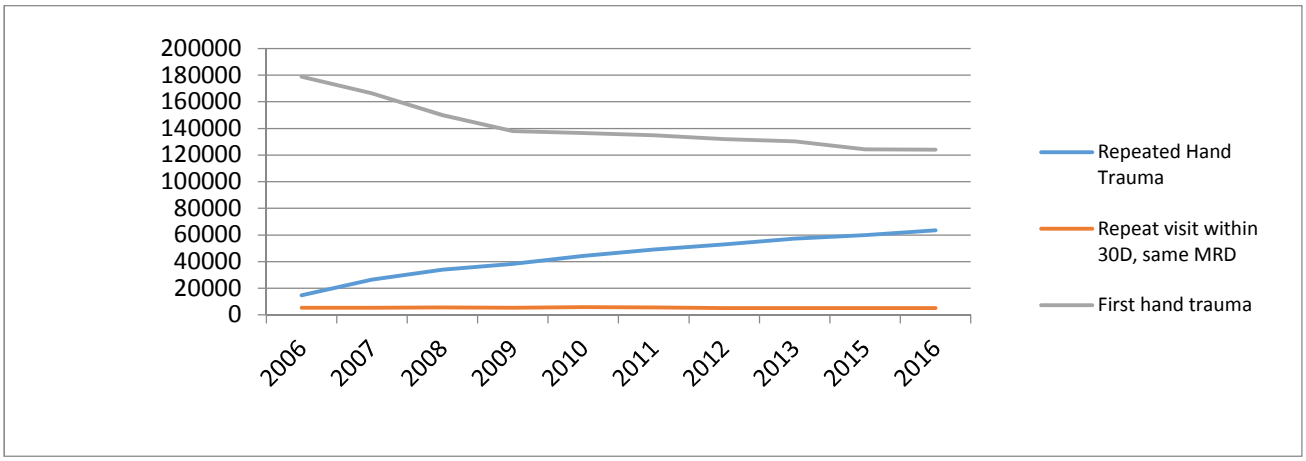

Figure 3.12: Temporal trends of first (index) hand, wrist and nerve trauma episode (grey) based on IKN, repeated hand, wrist and nerve trauma episodes (blue) based on repeated visits for the same IKN and repeated visit for the same diagnosis within 30 days of previous visit for the same IKN (orange).

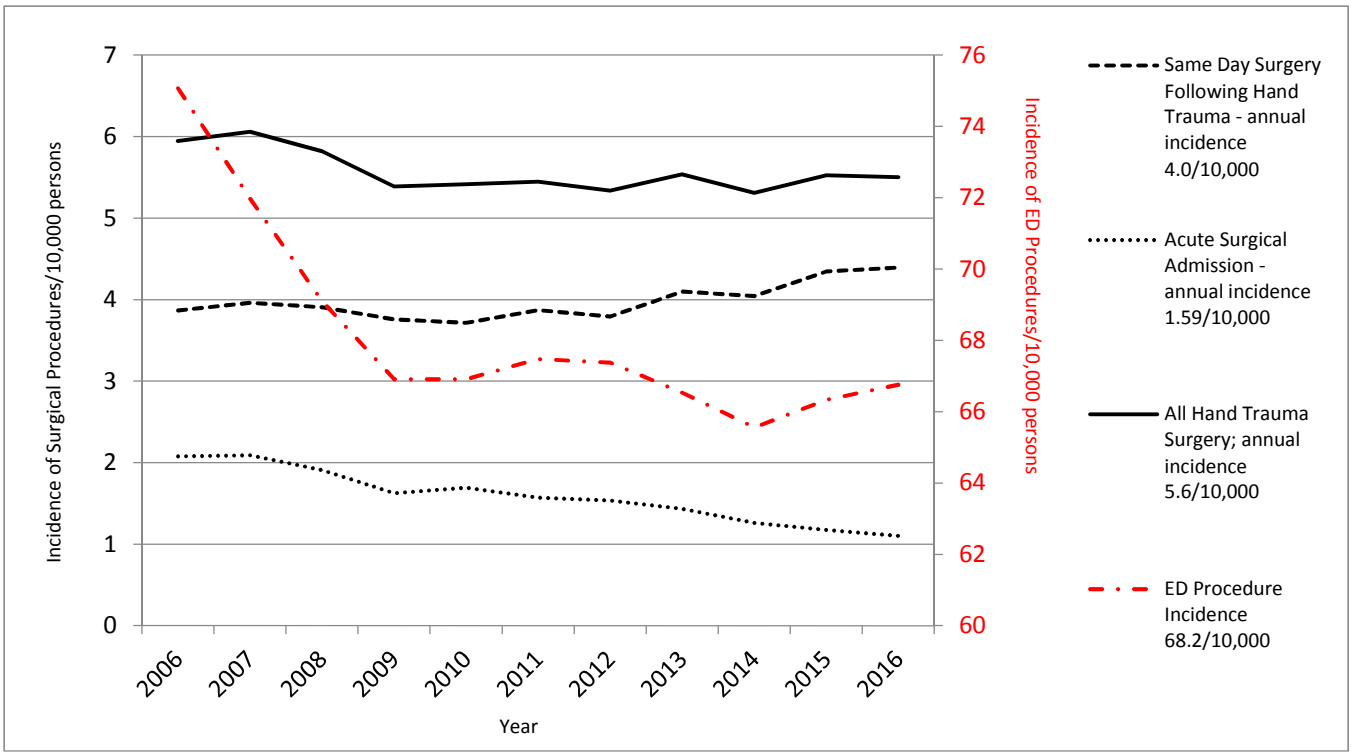

Figure 3.13: Temporal trends in annual incidence of ED procedures, Hand, wrist and nerve trauma surgery, Same day surgery for hand, wrist and nerve trauma and acute surgical admission for hand, wrist and nerve trauma.

Chapter 4: Study 2: Attributable Long Term Health Systems Costs Following Hand, Wrist and Nerve Trauma Among Ontario Adults

4.1 Index Surgical Hand, Wrist and Nerve Trauma Among Adults in Ontario (2006-2014)

The cohort of adult surgical hand, wrist and nerve trauma in Ontario included 26,141 subjects with index surgical hand, wrist and nerve trauma (annual incidence 3.6/10,000 persons, 95% CI: 3.4-3.87). Table 4.1 outlines the distribution of the incidence of hand, wrist and nerve trauma by LHIN demonstrating a higher incidence among patients in LHINs that were less populated. The majority of subjects were male (64.3%) with a mean age of 41.8 years (± 13.62) and most did not have significant associated comorbidities (ACG group 0-5: 88%). Subjects were evenly distributed between income quintiles with an average Ontario Marginalization Index of 3.09. Baseline utilization of health care was similar between cases and controls as evidenced by similar health care costs in the year prior to index. (Appendix 4.1) Previous year costs for cases were $1,707.61 and for controls were $1,773.88 (MSD = 0.01; $p = 0.18$).

4.2 Matching Results

After propensity-score matching, 26,123 (99.9%) of surgical hand, wrist and nerve trauma subjects were matched to subjects who did not have any hand, wrist and nerve trauma. The majority of cases (99.73%) were matched to four controls (Table 4.2). The total number of controls was 104,358.

Three year follow up was complete for 99.1% of cases (n = 25,875) and controls (106,388). Incomplete follow-up was secondary to death in 0.9% of both cases (n = 248) and controls (n =

970). After conducting the matches, all standardized differences for the baseline covariates were 0.1 or less (Appendix 4.1).

4.3 Outcomes

4.3.1 Patient Level Costing

Table 4.3.1 outlines the mean total and health care sector specific costs for both cases and controls. Total health care costs were significantly greater among cases relative to controls at all time points within three years from index. Cost discrepancy between cases and controls resulted from inpatient, outpatient, ED and primary health care provider services. Outpatient surgical services and specialist OHIP billing fees contributed more substantially to the total health care costs than other sources of costs. Adaptive devices were not significantly different between cases and controls within three years. Costs associated with MHA service accession were significantly greater among cases within the first year; however, by three years, MHA costs were similar between cases and controls.

Mean direct health care costs attributable to hand, wrist and nerve trauma within 3 years of the event were $8528.90. Two thirds of these costs were incurred within 30 days ($5,694.50) of the hand, wrist and nerve trauma and 88% were incurred within the first year ($7,519.80) (Table 4.3.2). Attributable costs accrued in years two and three post-hand, wrist and nerve trauma were substantially lower than the first. Physician fees, inpatient care and outpatient costs accounted for 25%, 28% and 34% of attributable health care costs, respectively.

4.3.2 Stratified Analyses of Attributable Health Care Data

Stratified analyses identified patient and injury factors that lead to increased attributable health care costs following hand, wrist and nerve trauma. Stratification did not identify any

significant differences in attributable costs following surgical hand, wrist and nerve trauma between men and women (Appendix 4.2). Patient factors that influenced attributable costs were age and MHA utilization following hand, wrist and nerve trauma. Injury factors including type of injury and inpatient surgery also lead to increased attributable costs.

Increasing age was associated with increased costs over the three years following the index hand, wrist and nerve trauma $7862 (18-30 years), $7,743 (31-40 years), $8,738 (41-50 years) and $9,272 (51-65 years) ($p$<0.001).

Approximately one third of hand, wrist and nerve trauma subjects required admission at the time of their surgery. Attributable costs of hand, wrist and nerve trauma that required outpatient surgery were approximately 40% of inpatient hand surgery subjects (30-day costs: $3,985 vs $9,346; $p < 0.001$; 3 year costs: $5,941 vs $14,058; $p < 0.001$). The main health care sector costs that contributed to the elevated attributable costs among inpatient hand surgical subjects were inpatient costs ($386 vs $6,795) and specialist fee for service costs ($1,513 vs $2,960).

Specific injury types generated greater attributable costs compared with the mean attributable cost for all injuries combined (p<0.001): burns ($16,100.24; n=189), amputations ($12,825.3; n=1,348), crush injuries ($11,985.31; n=198) and vascular injuries ($13,022.56; n=168). These injury types likely require admission for surgical management explaining the source of increased attributable costs. Figure 4.3.1 depicts the attributable costs within three years between injury type.

4.4: Resource Utilization Following Surgical Hand, Wrist and Nerve Trauma

Patients with hand, wrist and nerve trauma had greater resource utilization across all measured variables within three years (Figure 4.3.2). Hand, wrist and nerve trauma patients had more frequent visits to family physicians (≥5 visits: 39% v. 34%; p<0.001) and the emergency

department (≥3 visits: 25% v. 12%; $p<0.001$). Hand, wrist and nerve trauma subjects were more likely to have at least two surgeries (25% v. 5%; $p<0.001$), which demonstrates that a quarter of the hand, wrist and nerve trauma patients require at least one additional surgery above their initial surgery for the index hand, wrist and nerve trauma. One or more hospitalization occurred among hand, wrist and nerve trauma patients more frequently (29% v. 10%; p<0.001).

While both case and control cohorts demonstrated an increase in the proportion of subjects accessing MHA services within three years of index, the number of hand, wrist and nerve trauma subjects utilizing these services nearly doubled (Figure 4.3.2). At baseline, 18.3% of both cases and control cohorts had accessed MHA services within the year prior to index (NB: pre-index MHA utilization was a hard matching criteria for the propensity score match). Among controls, MHA service utilization increased to 28% and among cases, increased to 34%. Hand, wrist and nerve trauma subjects were more likely to access MHA services following the index trauma compared to controls (34% v. 28%; OR: 1.33, 95%CI:1.29-1.37). When stratified based on pre-index MHA service utilization, hand, wrist and nerve trauma subjects that did not have contact with MHA services in the previous year were more likely to require MHA services post-trauma (34% vs 23%; OR: 1.46, 95%CI: 1.41-1.52). Among subjects with pre-index MHA service utilization, hand, wrist and nerve trauma subjects were more likely to access these services following the trauma (27% vs. 22%; OR:1.3,95%CI:1.12-1.25).

Attributable health care costs within the first three years of index were greater in patients that utilized MHA services pre- and post-index (Figures 4.3.3 and 4.3.4); however, among hand, wrist and nerve trauma patients that utilized MHA services following index the attributable costs of hand, wrist and nerve trauma were significantly greater ($7,084 vs $11,359; p < 0.001) (Appendix 4.3 & 4.4). As depicted in Figure 4.3.4, attributable costs were continuing to accrue in subjects that accessed MHA services over the 3 years following trauma; however, the same trend is not seen in

the subjects that do not access MHA services where attributable costs demonstrate little accumulation one year after hand, wrist and nerve trauma.

4.5 Tables

Table 4.1: Average Annual Incidence of Index Surgical Hand, wrist and nerve trauma By LHIN

LHIN	Average Population	Avg incidence/10,000 persons 2006-2014
Erie St. Clair	412,709	4.2
South West	609,589	5.0
Waterloo Wellington	489,754	3.4
Hamilton Niagara	898,019	4.4
Central West	562,218	3.3
Mississauga Halton	755,941	3.1
Toronto Central	808,559	3.4
Central	1,160,543	2.6
Central East	1,019,340	3.8
South East	314,043	5.0
Champlain	835,615	3.0
North Simcoe Muskoka	290,862	4.5
North East	369,384	6.0
North West	153,557	5.2

Table 4.2: Number of controls to cases successfully matched.

Number of Controls Matched Per Case	Number of Cases
4	26,053 (99.73%)
3	23 (0.09%)
2	30 (0.11%)
1	17 (0.07%)
0	18 (0.01%)

Table 4.3.1: Mean total and health care sector specific costs for both cases and controls.

Cost Element	Controls N=104,353	Cases N=26,123	*p*-value
Total Health Care Cost	Mean $ ± SD	Mean $ ± SD	
1 Year Pre-Index	1,773.88 ± 7,336.57	1,707.61 ± 6,384.18	0.181
30 Days Post-Index	159.79 ± 1,158.37	5,854.74 ± 5,162.94	<.001
1 Year Post-Index	1,901.37 ± 8,703.59	9,351.01 ± 13,144.47	<.001
2 Years Post-Index	3,906.40 ± 15,816.68	11,785.35 ± 17,805.68	<.001
3 Years Post Index	5,981.77 ± 22,433.16	14,300.37 ± 23,670.28	<.001
Health Care Sector			
Inpatient Costs			
30 Days Post-Index	33.37 ± 750.96	1,805.77 ± 3,970.54	<.001
1 Year Post-Index	426.99 ± 4,996.95	2,461.65 ± 8,127.93	<.001
3 Years Post Index	1,352.16 ± 11,115.07	3,582.09 ± 12,358.51	<.001
Outpatient Costs			
30 Days Post-Index	16.07 ± 116.17	644.44 ± 544.98	<.001
1 Year Post-Index	189.50 ± 762.36	1,456.11 ± 1,562.35	<.001
3 Years Post Index	563.11 ± 1,772.84	2,024.04 ± 2,573.95	<.001
ED Costs			
30 Days Post-Index	7.73 ± 70.36	419.70 ± 339.09	<.001
1 Year Post-Index	90.26 ± 314.90	554.06 ± 559.93	<.001

3 Years Post Index	270.28 ± 717.15	820.39 ± 1,038.09	<.001
Outpatient Surgery Costs			
30 Days Post-Index	6.67 ± 102.65	1,151.86 ± 1,003.14	<.001
1 Year Post-Index	86.13 ± 453.44	1,469.70 ± 1,183.00	<.001
3 Years Post Index	263.32 ± 860.36	1,769.03 ± 1,519.23	<.001
Family Physician OHIP Billing			
30 Days Post-Index	12.68 ± 63.94	155.81 ± 247.70	<.001
1 Year Post-Index	148.29 ± 494.02	326.60 ± 556.36	<.001
3 Years Post Index	431.14 ± 1,528.42	665.45 ± 1,634.61	<.001
Specialist OHIP Billing			
30 Days Post-Index	30.86 ± 190.85	1,471.50 ± 1,396.39	<.001
1 Year Post-Index	369.47 ± 1,039.85	2,149.57 ± 2,059.98	<.001
3 Years Post Index	1,136.81 ± 2,502.03	3,123.66 ± 3,334.20	<.001
Adaptive Devices Cost			
1 Year Post-Index	5.97 ± 182.46	9.19 ± 244.17	0.018
3 Years Post Index	13.23 ± 291.94	15.16 ± 310.68	0.346
Mental Health and Addiction Service Cost			
30 Days Post-Index	6.80 ± 333.73	25.76 ± 605.62	<.001

1 Year Post-Index	85.04 ± 3,383.82	141.03 ± 3,716.70	0.019
3 Years Post Index	301.41 ± 9,555.28	373.60 ± 8,231.03	0.262
Prescription Drug Costs (ODB)			
30 Days Post-Index	14.77 ± 140.70	22.98 ± 164.21	<.001
1 Year Post-Index	186.68 ± 1,375.99	219.19 ± 1,427.92	<.001
3 Years Post Index	637.03 ± 4,073.31	708.56 ± 4,240.01	0.012
Long Term Care Costs			
1 Year Post-Index	32.02 ± 1,120.09	21.48 ± 804.03	0.152
3 Years Post-Index	112.08 ± 3,450.72	62.26 ± 2,206.03	0.026

Table 4.3.2: Costs attributable to surgical hand, wrist and nerve trauma within three years of the index event. (2014 $CAD)

Variable	**Mean CAD**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Total costs: 30 Days	5694.50	5631.50	5757.40
Total costs: 1 Year	7519.80	7361.40	7678.10
Total costs: 2 Years	8018.10	7794.00	8242.30
Total costs: 3 Years	8528.90	8217.50	8840.20
3 Year Attributable Costs By Health Care Sector			
ED Costs	486.70	471.90	501.50
Inpatient Costs	2429.00	2239.60	2618.50
Outpatient Costs	1437.50	1403.30	1471.60
Outpatient Surgery Cost	1493.10	1468.80	1517.40
Physician Cost	2200.80	2133.00	2268.60
Assistive Devices Costs	5.07	-1.66	11.80
MHA Costs	42.59	-66.59	151.80
Drugs and Laboratory	68.99	19.39	118.54
Long term Care Cost	4.30	-21.23	29.83
Non-Physician Cost	7.88	4.73	11.03

4.6 Figures

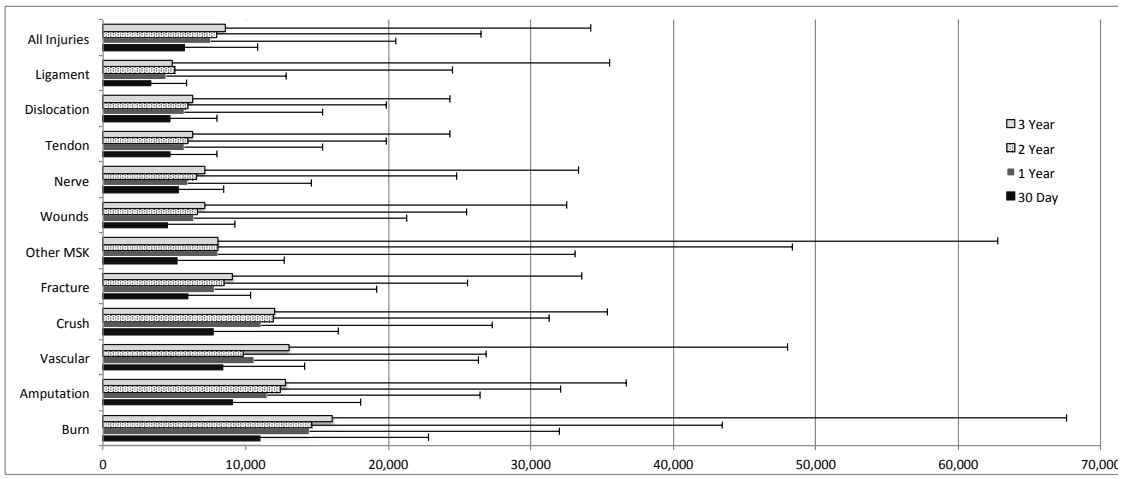

Figure 4.3.1: Attributable health care costs within 3 years for all injuries and by injury type.

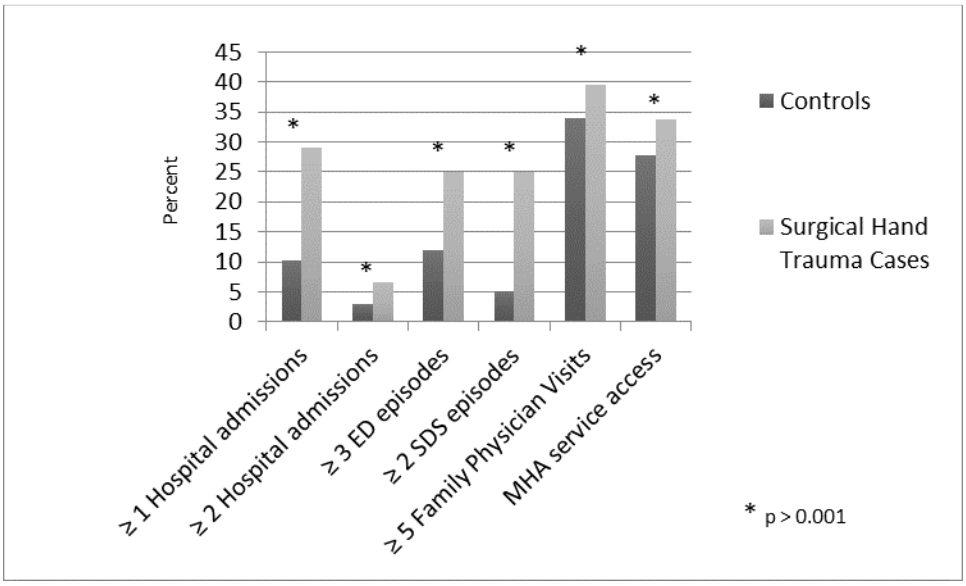

Figure 4.3.2 Proportional health care sector utilization between cases and controls within three years.

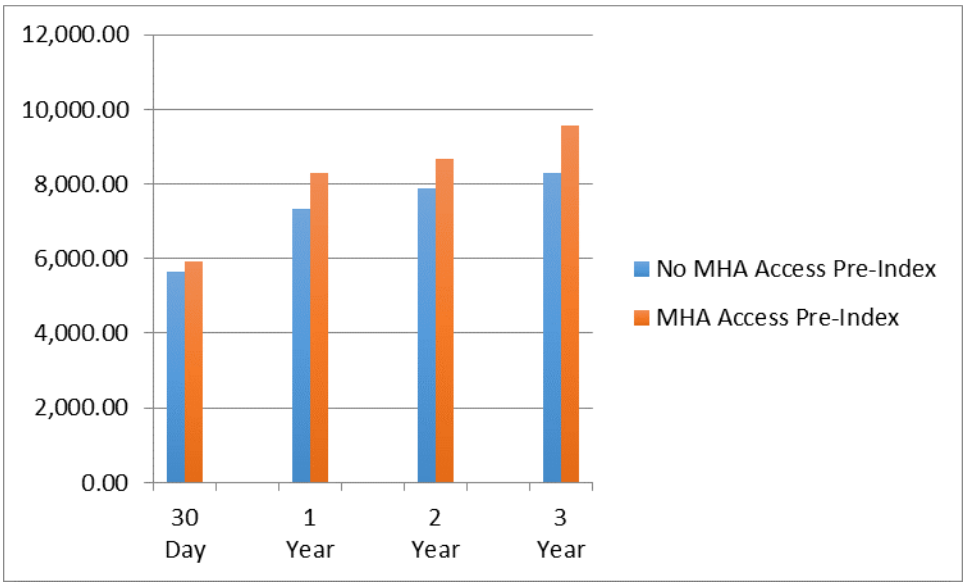

Figure 4.3.3: Total attributable health care costs following hand, wrist and nerve trauma stratified by pre-index utilization of MHA services at 30 days, 1, 2 and 3 years following hand, wrist and nerve trauma.

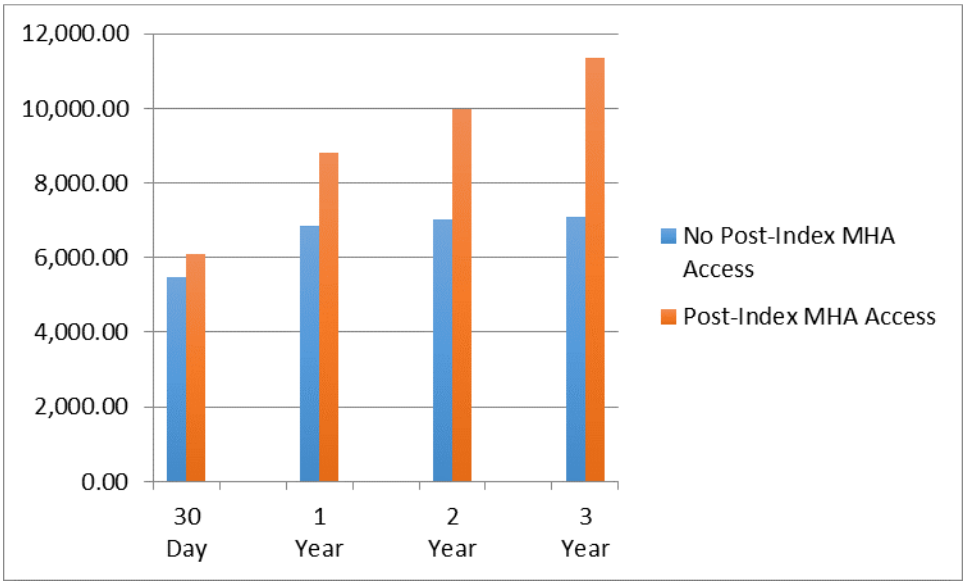

Figure 4.3.4: Total attributable health care costs following hand, wrist and nerve trauma stratified by post-index utilization of MHA services at 30 days, 1, 2 and 3 years following hand, wrist and nerve trauma.

Chapter 5 Discussion

5.1 Study 1: Hand, Wrist and Nerve Trauma Volumes in Ontario Adults

Isolated hand, wrist and nerve trauma is a very common presentation in Ontario Emergency Departments. In fact, as a cluster of diagnoses, it appears to be the most common reason for an adult to visit the ED. The annual average of ED visits among adults in Ontario for all causes has been over 3.4 million (20-64 years) based on 2013-2016 CIHI statistics [130]. This thesis research has revealed that, in comparison to these annual ED volumes, isolated hand and upper extremity trauma represents approximately 5.5% of all ED visits in Ontario among adults. These findings are consistent with reports from the United states, where all hand maladies (not exclusively trauma) and trauma-related hand complaints comprised 6.6% and 5.1% of all ED presentations, respectively.[7,12] All forms of trauma presenting to Ontario EDs lead to over 700,000 adult visits annually (CIHI Injury statistics) of which isolated handand upper extremity trauma comprises approximately 25%.[131]

Of the top ten diagnoses resulting in Emergency Department visits across Canada for all age groups, the diagnosis of "open hand and wrist wound" was consistently ranked seventh and was more common than other diagnoses, including sore throat and head wound (Table 5.1).[131] Adult hand, wrist and nerve trauma in Ontario generates a comparable annual volume of visits to back pain/dorsalgia across the entire Canadian population and substantially greater volume of visits than other top ten diagnoses, highlighting the significant burden of this form of trauma on Emergency Department. Further, the most common ED presentation, abdominal/pelvic pain if extrapolated to reflect the Ontario population (Annual average = 397,432, multiplied by a factor of

0.4), would produce approximately 158,973 visits annually. The volume of hand, wrist and nerve trauma episodes most certainly exceeds abdominal/pelvic pain visits demonstrating the relative burden of this public health issue. After identifying this significant public health issue, we now need to consider the role of primary and secondary hand, wrist and nerve trauma prevention in certain populations. Further, we need to consider the impact that hand, wrist and nerve trauma has on utilization of health care resources and potentially broader socioeconomic implications for patients and communities.

Table 5.1: Comparison of isolated adult hand, wrist and nerve trauma volume in Ontario to volumes of the most common presenting complaints to the ED in Canada for all ages.

Diagnosis	Population	Average Annual Volume of Emergency Department Visits
Isolated hand, wrist and nerve trauma	Adult (**Age: 18-65**) Geography: **Ontario**	N = 187,490*
Abdominal/Pelvic Pain (most common presentation)	All (**Age 0-105**) Geography: **Canada**	N = 397,432*
Dorsalgia	All (**Age 0-105**) Geography: **Canada**	N = 189,414**
Hand and wrist wound	All (**Age 0-105**) Geography: **Canada**	N = 153,516**
Sore Throat	All (**Age 0-105**) Geography: **Canada**	N = 130, 562***
Head wound	All (**Age 0-105**) Geography: **Canada**	N = 137,143****

*2013-2016 for comparison with available CIHI data
**2013-2016 CIHI data
***2014 CIHI data
****2013,2015-16 CIHI data

The list of ICD-10 diagnostic codes used to identify hand, wrist and nerve trauma was very inclusive with burns and wounds at any level in the upper extremity, fractures at or below the elbow and nerve injuries included between the brachial plexus and the digital nerves. The

extensive list was inclusive to represent the casemix seen by upper extremity surgeons from different backgrounds treating any upper extremity nerve injury, forearm, wrist and hand injuries. Nerve injuries at a proximal level affect the downstream sensory and/or motor targets are are treated by orthopedic, plastic and peripheral nerve surgeons. Wounds, crush injuries and dislocations at more proximal levels in the upper extremity were included as this may be documented as the most responsible diagnosis, but more extensive soft tissue (muscle or nerve) injury can often lie beneath (n=34,960, 1.7%). Trauma at the elbow and proximal accounted for n=58,001 episodes (2.8%). The inclusivity of codes may over-estimate the incidence of isolated hand and upper extremity trauma and further sensistivity analysis excluding these codes could be performed to ensure that this has not affected the cost analysis in the second study.

The temporal trends (Figures 3.2, 3.3 and 3.4) demonstrate that the pattern of hand, wrist and nerve trauma incidence is not static with time and is different between men and women. The overall trend of hand, wrist and nerve trauma incidence had a decline that was most pronounced in the interval between 2006-2010 for both sexes, but was more pronounced among men than women (Δ -13% vs Δ -6%, respectively). Subsequent to 2010, men and women again demonstrate differential trends with male incidence declining (Δ -3.5%) and female incidence increasing (Δ +5.5%). The abrupt change in the temporal trend that occurs with an inflection point in 2009 requires further investigation. It is possible when working with temporal data to see inflection points such as this if there is a coincident change with coding or data collection practices. There was a transition from ICD-9 to ICD-10 coding in Ontario in 2002. For this reason, we allowed for a transition period of four years (2002-2006) for adjustments to be made in coding and data collection practices. As such, we do not believe that this is the source of the inflection point. As noted above, the magnitude of the decline between 2006-2009 differs by sex. This decline is also not consistent between injury type (Appendix 5.1) where the decline is clearly evident in the wound category (Δ -9.9%) and burn (Δ -12.3%) categories; however, an increase over the 2006-9

interval is seen other categories such as fractures and ligamentous injuries (Δ +3% vs Δ +4.8%, respectively). Further investigations would include sensitivity analyses where diagnoses are excluded by region or type to identify if there is sampling error introduced. In addition to this, multivariate techniques such as join point regression analysis will be applied to evaluate the inflection points in an adjusted manner (e.g. by sex, age, work-related injury) provide a more robust explanation of the temporal trend.

Seasonal variation in hand, wrist and nerve trauma volumes demonstrate different patterns between males and females (Figure 3.3). Males have substantially greater volumes of hand, wrist and nerve trauma in the summer months than winter months. While women demonstrate an annual peak in the June – September interval, it is not of the same magnitude observed in men. There is also a prominent annual increase in female hand, wrist and nerve trauma volume between December and February, which is not present among males. Differences in these temporal variations between sexes further highlights the likely differences in mechanisms. Specifically, falls have a very different pattern between females and males (Figure 3.6).

5.1.2: Hand, Wrist and Nerve Trauma in Females and the Relationship to Falls and Increased Age

Our investigation of sex-related differences would support that men and women are sustaining hand, wrist and nerve trauma in different age groups, by different mechanisms and resulting in different injury types. As such, in order to understand potential primary prevention measures, sex-specific considerations are necessary. Women that are older are more likely to sustain hand, wrist and nerve trauma (Figure 3.4) and further women are more likely to sustain hand, wrist and nerve trauma secondary to falls compared with men. This information could provide a plausible explanation to the seasonal variation seen in Figure 3.3: women having falls and sustaining injuries such as fragility fractures. When we examine these trends further, we can see

that seasonal fracture patterns between men and women are different; men have greater volumes of fractures in the summer months while women have greater fracture volumes in the winter months. Females have a large peak in hand, wrist and nerve trauma from falls in winter months that is of a similar volume to the hand, wrist and nerve trauma episodes in males during the same seasonal period. Male hand, wrist and nerve trauma represents >60% of isolated hand, wrist and nerve trauma episodes in Ontario. This seasonal peak in female hand, wrist and nerve trauma secondary to falls in winter months that is of equal volume to males identifies this source of hand, wrist and nerve trauma in females as a potentially preventable cause.

There has been a substantial population increase among the 50-64 year age category relative to the other age categories among women (Appendix 5.2). If older women have a greater propensity to sustain hand, wrist and nerve trauma, and this segment of the population is increasing, this could support the trend of increasing female hand, wrist and nerve trauma in Ontario.

Further investigation into the incidence of falls in adult populations and the relationship to hand, wrist and nerve trauma is warranted. Fall prevention programs are common[132], but are targeted toward senior citizens. These data indicate that there may be impetus to expand these programs to target a broader cohort that includes non-senior citizens. Further, guidelines exist for osteoporosis screening in Canada [133] and include a directed history and physical examination for risk of falls and fracture in individuals aged 50 or greater. Distal radius fractures are the most common index fragility fracture and should trigger an osteoporosis screening care pathway.[133,134] In Ontario a Fracture liaison services (FLS) has been advocated and increasingly implemented to improve secondary fracture prevention for fragility fracture patients.[135]

5.1.3 Hand, Wrist and Nerve Trauma in Males and the Relationship to Changes in Employment Industry

The decline in hand, wrist and nerve trauma in the 2006-2009 interval is evident in both sexes, but is certainly more pronounced among men. Although the consistency and accuracy of ICD10 coding for workplace injuries is not known, our study demonstrates that male hand, wrist and nerve trauma was associated with work-related circumstances. Between 2011-2017, the Workplace Safety Insurance Board reported on average greater than 11,000 upper extremity injuries per year (>20% of all WSIB injury claims) with males comprising 64% of these claims.[136] Taking workplace and employment type into consideration may also shed light onto trends in male hand, wrist and nerve trauma.

Over 2004-2009, the manufacturing sector in Ontario had a significant decline due to the introduction of automation and increased global competition.[137] During the 2008 recession, the Canadian manufacturing industry was impacted far greater than other sectors: gross domestic product volumes in the manufacturing sector declined at an annual average rate of around 9% in 2008-2009 compared with 2% in the business sector[138] Ontario labor force statistics demonstrated a significant decline in employment in the manufacturing sector in the 2006-2009 interval overall but most notably among men (Figure 5.1).[1] While a strong correlation is seen between male hand, wrist and nerve trauma episodes and the number of individuals employed in the manufacturing industry ($r = 0.91$, $p < 0.001$), there is no significant correlation between the overall volume of hand, wrist and nerve trauma or the volume among females ($r = 0.57$, $p = 0.067$ and $r = -0.34$, $p = 0.26$, respectively). This potential relationship highlights the need for further investigation into the true incidence of work-related injuries and potential preventative strategies. If work-place injuries are in fact, a driver in hand, wrist and nerve trauma, there is a demonstrable need to develop specific guidelines for hand protection and specific garments that are task-dependant. Currently there are Canadian Safety Association (CSA) standards for respiratory, eye, hearing, foot, head and fall protection,[139] but no standards for hand protection. Very little information is available regarding

hand protection equipment through the Ontario Ministry of Labour or in other provincial worker safety organizations aside from general recommendations.[140,141] There is certainly potential to raise awareness delve deeper into job-specific protective devices.

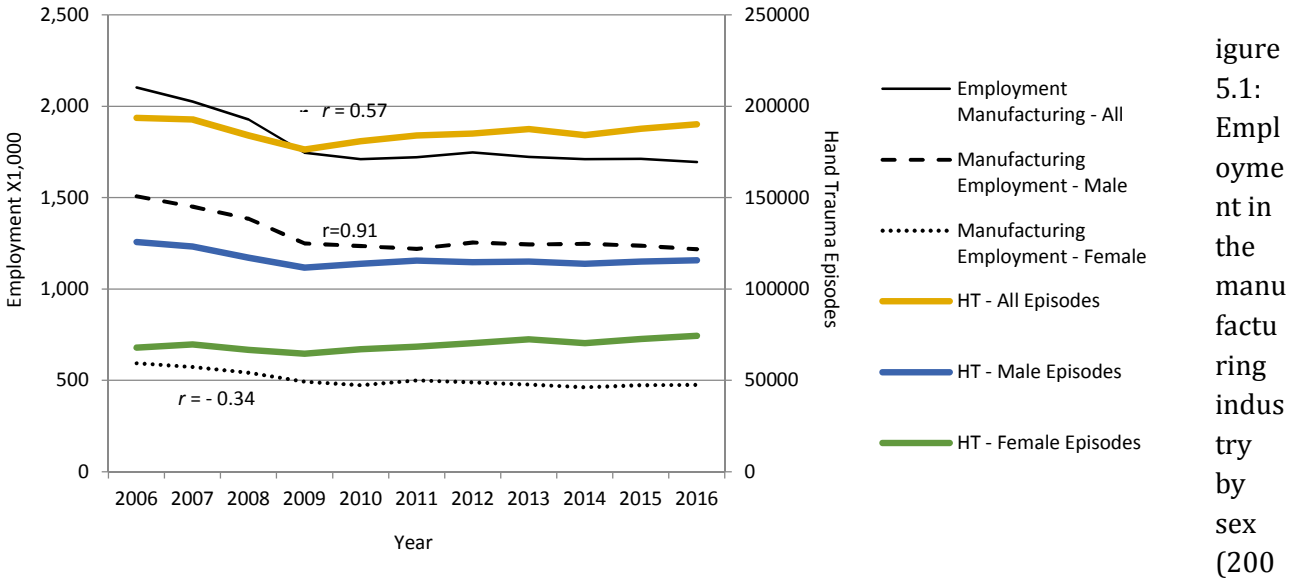

Figure 5.1: Employment in the manufacturing industry by sex (2006-2016)[1]

5.1.4 Socioeconomic Implications of Hand, Wrist and Nerve Trauma

The majority of patients will lose or have compromised use of the injured hand for a variable period of time following the trauma. This disability may prevent participation in work and home duties. Post-operative recovery, hand therapy, follow-up appointments and potentially additional reconstructive operations, utlimately require further time away from work and additional incurred expenses.[142–146] As a result, hand injuries can lead to economic burden for patients in three ways: direct loss of household income, direct costs associated with treatment (e.g. travel, parking, medications), and indirect costs (e.g. paying for help in the home).

This epidemiologic study has identified that subjects who resided in areas with lower median income, particularly the lowest income quintile, had a greater incidence of hand, wrist and nerve

trauma (Figure 3.7& 3.8). It is more likely individuals that reside in lower income neighborhoods are engaged in employment that requires use of both hands to safely complete tasks, as such putting these individuals at risk for lost income and further economic compromise. We have previously identified that patients have increased out-of-pocket costs (around $500CAD) in the first month after injury[147] and it is well known that there are significant lost opportunity costs faced by patients. [8] Indirect costs range from $1046 USD following Osteoporotic wrist fractures in Slovenia[36] to $169,408 following major/severe acute hand, wrist and nerve trauma in Sweden [4]. A compilation of all reports of indirect costs in the acute period following hand and wrist trauma identified the mean indirect cost/case as $7999 USD [43]. Further, a hand, wrist and nerve trauma, whether or not work-related, may have long-term effects for employability and earning potential. Particularly in the setting of severe injuries such as crush, mangling and amputation injuries. This study identified just under 5,000 of these devastating hand injuries per year in Ontario.

The average annual provincial incidence of isolated hand, wrist and nerve trauma is 211/10,000 persons. The seven LHINs that fell above the provincial average (Figure 3.9) were less densely populated with an inverse relationship existing between LHIN population and average incidence of hand, wrist and nerve trauma. As in most non-metropolitan areas, manufacturing is a major source of employment.[148,149] The potential implications of higher incidence of hand, wrist and nerve trauma in these more rural regions include economic and non-economic losses to the hand, wrist and nerve trauma patients and as well as lost production for potential employers. Much of the mainstay of the contemporary rural Ontario economy has been the manufacturing sector with an estimated 21% of manufacturing jobs being held in rural Ontario and also includes the mining and agriculture industries.[149] The broader socioeconomic implications of hand, wrist and nerve trauma for patients, employers and the local economy is an important subject that has not yet been studied in Ontario or Canada; however, this epidemiologic study alludes to the potential for significant socioeconomic losses simply due to the magnitude of this population health issue and

the demographics of the population most affected.

5.1.5 Health Care Utilization Following Hand, Wrist and Nerve Trauma

Hand, wrist and nerve trauma is one of the most common presentations to the ED, which by sheer volume, will result is substantial utilization of health care resources in the acute period. On average there are 185,995 visits to the ED for isolated adult hand, wrist and nerve trauma annually and on average each hand, wrist and nerve trauma episode utilizes 2.5 hours from triage to discharge (Table 3.1), which translates into approximately 1,274 hours of ED health care per day dedicated to hand, wrist and nerve trauma patients across the province. Further, there are approximately 177 ED facilities in Ontario providing data to NACRS, which translates into approximately 3 ED visits per day at each facility across the province for isolated hand, wrist and nerve trauma (in adults only). Approximately 10% of hand, wrist and nerve trauma episodes result in ED visit greater than the acceptable Ontario ED wait time of 4 hours (Table 3.4). While 10% is a relatively small proportion of hand, wrist and nerve traumas, this proportion would result in approximately 18,000 ED visits/year in Ontario that exceed expected wait times. Emergency Department crowding and "hallway medicine" are real issues in Canadian health care and as such are such prominent topics in the media and political discussions in.[150,151] It is essential to identify contributors to these issues and seek creative solutions; hand, wrist and nerve trauma is a possible candidate.

In this study, we have been able to identify that about 25% of all hand, wrist and nerve trauma episodes are repeated and that 22.5% of hand, wrist and nerve trauma patients are having injury recidivism (Figure 3.6). One Canadian study using trauma registry data reported 2% recidivism among major trauma patients.[19] Another Canadian health administrative study found that 23% of patients admitted for a burn injury returned to the ED secondary to an external cause of injury [152]. American trauma registry studies have demonstrated 7-9% recidivism.[153,154]

Compared to these trauma registry studies, hand, wrist and nerve trauma recidivism is substantially greater with the exception of the burn population, demonstrating the need for a deeper investigation to understand the unique nature of recidivism in the hand, wrist and nerve trauma population. Further investigation could take the form of a regression analysis among the cohort already identified with adjustments for potential risk factors. These risk factors would include, but are not limited to, age, sex, prior MHA service access, rurality index, income quintile and markers of deprivation such as the ON-Marg score.

In our study, either the same patient is returning to the ED for the same issue in a close temporal relationship to the index event, or they have a new hand, wrist and nerve trauma episode subsequent to the index. Repeated episodes of hand, wrist and nerve trauma may represent an avoidable and unnecessary strain on the health care system and contribute to issues of Emergency Department congestion. Between 2010-2014, approximately 280,000 visits to the ED each year were considered avoidable and "family practice sensitive conditions" (FPSCs).[155] Our analysis of repeated hand, wrist and nerve trauma episodes has identified that annually there were approximately 5,400 repeated hand, wrist and nerve trauma visits within the same month for the same primary diagnosis. These visits likely represent a source of potentially avoidable visits to the ED, or FPSCs, such as suture removal and dressing or cast issues. Figure 3.12 demonstrates that these types of episodes are relatively stable over time.

Interestingly, the volume of index hand, wrist and nerve trauma appears to be declining while the volume of repeated episodes appears to be increasing over the study period (Figure 3.11). This disparity in trends most likely represents the cumulative effect of annual growth in the pool of index hand, wrist and nerve trauma patients who appear to have higher propensity for subsequent hand, wrist and nerve trauma to the rest of the population. Preliminary analysis suggests an association between repeated hand, wrist and nerve trauma episodes and male sex, rural residence

and MHA utilization in the year prior to index hand, wrist and nerve trauma. Among major trauma patients in the US, risk factors for trauma recidivism included male sex, African American ethnicity, penetrating injury and elevated blood alcohol at initial presentation [154]. Among an American burn population, MHA disorders were approximately five times greater among recidivists compared to non-recidivists. In a Canadian burn population, recidivism rates were significantly lower among patients who admitted to an established burn centre, from which the authors concluded that a more comprehensive and multidisciplinary care setting can inform the delivery of post-acute health service delivery for burn survivors [152]. Further investigation to better understand the population having repeated episodes is warranted as this may direct the potential for secondary prevention of hand, wrist and nerve trauma.

Patients with a previous MHA diagnosis are at increased risk of trauma, including repeated trauma, and more likely to develop complications and chronic pain following trauma.[81–83] These patients have also demonstrated less engagement with ongoing health care, which contributes to poorer outcomes.[73] The association of the MHA population to repeated hand, wrist and nerve trauma requires further investigation, taking into consideration that MHA patients are a prominent subpopulation that utilizes a disproportionately greater share of resources ("high cost patients") than the general patient population.[70–72]. Further, hand, wrist and nerve trauma patients with pre-morbid MHA issues are also more likely to be more marginalized based on their ONMARG scores and income quintile. These MHA issues, compounded by a marginalized status are not ideal circumstances to achieve adherence to treatment, appropriate follow-up and optimal outcomes following hand, wrist and nerve trauma. These individuals are also at increased risk of repeated episodes. These findings highlight the potential benefit of access to allied health care services that could address some of the psychosocial factors that are prevalent among subpopulations of hand, wrist and nerve trauma patients, which has been demonstrated in other trauma populations [152].

5.1.6 Limitations

There is no validated means to identify hand, wrist and nerve trauma patients, which represents a diverse group of injuries. In this study, a primary ICD-10 code representing acute trauma to the hand, wrist, forearm or peripheral nerves at any level of the upper extremity (Appendix 2.1) was required. Challenges in subject identification of a specific cohort that can impose limitations on this study are due to absence of ICD10 codes or invalid use of diagnosis, procedure or billing codes. However, both primary diagnosis and procedure coding in hospital and OHIP databases have been shown to have approximately 85% accuracy ,[94], which is important as these are the data sources used in this research. A natural next step would be a validation study. This study only focused on adults 18-65 years. This was done as the injury patterns may be less clear with all patients included. Future studies will examine similar patterns and volumes in pediatric and older patients. Our study may also underestimate the volume of hand, wrist and nerve trauma because episodes of hand, wrist and nerve trauma were excluded in the context of polytrauma. Future studies could examine the frequency of hand, wrist and nerve trauma in the setting of polytrauma and the impact that this has on the hand injury, which usually does not take precedence.

5.2 Discussion Study 2: Attributable Health Care Costs of Surgical Hand, Wrist and Nerve Trauma within Three Years

5.2.1: Interpretation

We found the attributable health care cost of index surgical hand, wrist and nerve trauma to be $7519 in the first year with an increase to $8528 within three years of injury. This per-person cost translates into approximately $25 million annually following the index hand, wrist and nerve

trauma events and a further $3.3 million of direct healthcare expenditures in the subsequent two years. Study 1 has demonstrated that trauma is one of the most common reasons to present to the ED with repeated episodes of hand, wrist and nerve trauma being very common. Approximately 4/10,000 Ontarians have an index hand, wrist and nerve trauma that requires surgery on an annual basis, while all ER episodes of hand, wrist and nerve trauma that result in surgery is approximately 6/10,000 (Study 1). Extrapolating these per-person attributable costs based on the annual population estimate of surgical hand, wrist and nerve trauma in Ontario, the overall estimate to manage surgical hand, wrist and nerve trauma is greater than $36 million within the first year and an additional $4.9 million in the subsequent two years. Further extrapolation of these per-person costs to estimate the annual cost of all isolated hand, wrist and nerve trauma including surgical and non-surgical, based on the annual incidence (211/10,000 persons), suggests costs in the first year following hand, wrist and nerve trauma may be greater than $400 million. This is close to 1% of the annual health care budget in 2014-5 in Ontario ($50.2 billion).

The Economic Burden of Illness of Canada 2005-2008 report outlines the direct medical costs of the five diagnostic categories with the highest total costs [156]. Injury is among these diagnostic categories leading to attributable costs of $8.1 billion in 2008, which, based on the volume of injuries presenting to the ED would translate to approximately $2500/injury in Ontario[130]. The cost of managing surgical hand, wrist and nerve trauma within the first year ($7518/injury) is substantially greater in comparison to this estimate for all injuries in Ontario.

Little research has been conducted on attributable longitudinal health care costs following trauma and no research has been conducted specifically for hand, wrist and nerve trauma. A Canadian study of the attributable health care costs of both motorcycle and automobile collision reported $5825 and $2995 (CAD), respectively, over two years following the collision[114]. In Ontario, over 26 thousand people in were injured during the 7 year study period in motorcycle crashes and

nearly 282 thousand injured in automobile crashes [114]. These costs represent a spectrum of injury severity among motor vehicle collisions and our study represented surgical hand, wrist and nerve trauma only, which likely explains the discrepancy between the attributable costs following MVC and hand, wrist and nerve trauma. Yet, the cumulative cost of hand, wrist and nerve trauma (both surgical and all hand, wrist and nerve trauma) would most likely surpass either the motorcycle or automobile crash populations due to both the greater attributable costs and the higher volumes of hand, wrist and nerve trauma (~187,000/year). This comparison illustrates the significant economic burden hand, wrist and nerve trauma may create for the health care system when related to other common mechanisms of injury.

Direct costs following fractures among elderly Canadians within the first year were variable with hip fractures being the most costly: hip/femur fracture $46,664, wrist fracture $5,253, and fractures at other peripheral sites $10,410 [157]. Wrist fracture costs are approximately one ninth of the cost of hip fractures in this study, likely due to discrepancies in relative proportions of patients requiring surgery and hospitalization [158]. Further study of the hip fracture population has demonstrated the mean direct attributable cost in the first year after hip fracture in Ontario to be > $39 thousand [59,159]. This per person cost translates into a estimated annual total attributable cost for all hip fractures of $282 million in Ontario and $1.1 billion in Canada, based on 30,000 fractures nationally/year. Comparison of the mean direct healthcare costs attributable to hip fractures to surgical hand, wrist and nerve trauma in the first year following injury demonstrates a substantially greater economic burden on a per-person basis; however, when taken into the context of >180 thousand hand, wrist and nerve traumas/year in Ontario (Study 1) there is potential for hand, wrist and nerve trauma to far surpass the economic burden of hip fractures in the elderly, highlighting the need to further study direct healthcare costs attributable to hand, wrist and nerve trauma beyond patients requiring surgery.

Stratified analyses of patient populations has identified that certain populations of surgical hand, wrist and nerve trauma patients generate greater mean attributable health care costs. Certain injury types including burn, amputation, crush and vascular injuries were associated with greater mean attributable healthcare costs (Figure 4.3.3). While hand, wrist and nerve trauma is diverse in injury types, these injuries are the more severe presentations. These injuries require more comprehensive acute care, likely requiring hospital admission, which is demonstrated by the greater 30-day costs. Further to this, these injury types can require revision surgeries and lengthy follow up care over many years, as evidenced by the greater costs at one year post-injury and extending to three years post-injury. Mean attributable costs following inpatient surgery were significantly greater than outpatient surgery, highlighting a potential discrepancy in attributable cost based on injury type (30-day costs: $3,985 vs $9,346; $p < 0.001$; 3 year costs: $5,941 vs $14,058).

Another patient stratum with significantly greater mean attributable costs were those that accessed mental health and addiction services. MHA diagnoses following hand, wrist and nerve trauma are well documented.[78,160,161]. Results of the Canadian Community Health Survey (CCHS) revealed that 10.1% of Canadians >15 years of age reported symptoms consistent with one of six mental health or substance abuse disorders within the year preceding the survey [162]. Approximately 18% of the surgical hand, wrist and nerve trauma cohort had accessed MHA healthcare services in the year preceding the index event, indicating that pre-existing MHA may be related to sustaining a hand, wrist and nerve trauma. Patients with MHA diagnoses prior to having any trauma are known to have increased risk of intentional injuries, such as self-harm or assault, but are also at increased risk of unintentional injuries, such as falls or motor vehicle collisions; however, this has not been studied among hand, wrist and nerve trauma patients [83,101]. Thirty-four percent of the surgical hand, wrist and nerve trauma cohort accessed MHA services following their injury. These findings identify that not only are the MHA service needs among surgical hand, wrist

and nerve trauma patients significantly greater than at baseline in this specific cohort, (18% vs 34%), but they are over 3 times greater (10.2% vs. 34%) than self-reported MHA symptoms among Canadians. Our data demonstrates the actual proportion of patients accessing MHA services, but may grossly underestimate the proportion of patients that would actually endorse symptoms consistent with MHA diagnoses. Figure 4.3.3 and 4.3.4 also demonstrate a difference in attributable costs of surgical hand, wrist and nerve trauma over time between patients that accessed MHA services before hand, wrist and nerve trauma and after hand, wrist and nerve trauma. While costs continued to rise in both groups over the three year period, this trend was more marked among those accessing MHA services after surgical hand, wrist and nerve trauma. After traumatic hand injury, extensive physical and psychological adaptation is required following surgical reconstruction. Recovery from injury can be emotionally challenging, which may result in impaired quality of life and delayed physical recovery. Hand injury also imposes limitations on vocational and avocational activities and creating economic and non-economic losses for patients. It is estimated that hand, wrist and nerve trauma patients require an average of 8 weeks away from work [163]. We have previously identified that patients have increased out-of-pocket costs (~ $500CAD) in the first month after injury [147] and it is well known that there are significant lost opportunity costs faced by patients [4,5]. The addition of financial burden for patients understandably compounds post-traumatic MHA issues further.

5.2.2 Limitations:

While administrative data available for health care costing studies captures approximately 92% of publicly funded health care costs to residents of Ontario [113] there are costs for which we are unable to account in this population, including patients receiving non-physician treatments (e.g. occupational and physical therapy, chiropractic treatments, etc.) outside of OHIP. Of importance among this demographic is a lack of OHIP-eligibility for coverage of occupational and physical

therapy (hand therapy), which is critical in the recovery of most hand injuries to some extent. In our previous work looking at hand, wrist and nerve trauma patient out-of-pocked costs (OOPC), patients incurred over $300 CAD within the first 4 weeks following the hand, wrist and nerve trauma (>60% of total OOPC). [147] A further study could compare longterm attributable costs between facilities where hand therapy was available with OHIP funding to facilities where it is not. Further, injured workers can receive care through a Workplace Safety Insurance Board-preferred healthcare providers, which is reimbursed outside of OHIP. All patients were identified based on the index event in NACRS and, although this has not been studied, there is a substantial population of patients that sustain a hand, wrist and nerve trauma, present to a primary care provider outside of the emergency department and are referred to a surgeon for definitive care. The costs described in this study are limited to isolated surgical hand, wrist and nerve trauma and do not describe the attributable costs of hand, wrist and nerve trauma among all patients. Approximately 4/10,000 having index hand, wrist and nerve trauma annually in Ontario, while all ER episodes of hand, wrist and nerve trauma that result in surgery is approximately 6/10,000 (Study 1). Overall 35% of ER hand, wrist and nerve trauma requires a procedure in the acute period with an incidence of 68/10,000 having procedures in the ER. These costs of non-index hand surgeries and more common ER procedures are not captured, nor are non-surgical hand, wrist and nerve traumas which requires further study.

5.3 Conclusions and Future Directions:

This research represents the first step toward a better delineation of a significant, yet relatively understudied public health issue in Ontario: hand, wrist and nerve trauma. This work demonstrates not only the tremendous volume that hand, wrist and nerve trauma generates as a burden on the health care system, but also highlights some potential means for primary and secondary prevention, which is a novel contribution to our current understanding of the problem.

Future studies that could address these knowledge gaps would be a more in-depth analysis of sex differences in hand, wrist and nerve trauma, an evaluation of risk factors for repeated hand, wrist and nerve trauma, and the patterns of hand, wrist and nerve trauma among marginalized patients. Since this work is limited to the 18-65 year old cohort, a description of the epidemiology of hand, wrist and nerve trauma in the pediatric population and the >65 year old population is also necessary, as there may be patterns that allude to further preventative strategies.

Another contribution of this work is the description of long term attributable costs of surgical hand, wrist and nerve trauma. The economic burden of illness arising from hand, wrist and nerve trauma has not previously been demonstrated using an incremental cost methodology, which is the most accurate means of identifying the costs arising from a specific condition. [57,58] There are no studies of this type to describe the longitudinal patient-level costing following hand, wrist and nerve trauma. Our analysis focused on surgical hand, wrist and nerve trauma patients alone in order to limit the heterogeneity of the cohort, however, due to the high incidence of hand, wrist and nerve trauma, an overall understanding of the longitudinal attributable costs would be helpful to more definitively describe the economic burden of the public health issue. This analysis also demonstrated that there are likely high-cost groups of hand, wrist and nerve trauma patients. Future research dedicated to delineating the high cost hand, wrist and nerve trauma patient will help to shape integrated models of care directed at populations at risk for higher costs in order to improve their health care experience and outcomes following hand, wrist and nerve trauma.

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Appendices

Appendix 2.1: Primary ICD-10 codes representing acute trauma to hand, wrist, forearm or peripheral nerves of the upper extremity

Primary ICD-10 Code	Description ICD-10 Code	Frequency	Percent	Cumulative Frequency	Cumulative Percent
S6100	**Open wound of finger(s) without damage to nail, uncomplicated**	524200	25.62	524200	25.62
S6190	**Open wound of wrist and hand part, part unspecified, uncomplicated**	139663	6.83	663863	32.45
S609	**Unspecified superficial injury of wrist and hand**	100252	4.9	764115	37.35
S699	**Unspecified injury of wrist and hand**	97531	4.77	861646	42.11
S6180	**Open wound of other parts of wrist and hand, uncomplicated**	84141	4.11	945787	46.23
S608	**Other superficial injuries of wrist and hand**	58562	2.86	1004349	49.09
S6359	**Unspecified sprain and strain of wrist**	55881	2.73	1060230	51.82
S602	**Contusion of other parts of wrist and hand**	51040	2.49	1111270	54.32
S5190	**Open wound of forearm, part unspecified, uncomplicated**	40982	2	1152252	56.32
S52590	**Unspecified fracture of lower end of radius, closed**	37371	1.83	1189623	58.15
S62600	**Fracture of middle or proximal phalanx of finger, closed**	35663	1.74	1225286	59.89

S6101	**Open wound of finger(s) without damage to nail, complicated**	35506	1.74	1260792	61.62
S62610	**Fracture of distal phalanx of finger, closed**	31394	1.53	1292186	63.16
S62390	**Fracture of unspecified site of other metacarpal bone, closed**	27174	1.33	1319360	64.49
S62000	**Fracture of navicular [scaphoid] bone of hand, closed**	26312	1.29	1345672	65.77
S52100	**Fracture of head of radius, closed**	26248	1.28	1371920	67.06
S6369	**Unspecified sprain and strain of finger(s)**	25336	1.24	1397256	68.29
S6110	**Open wound of finger(s) with damage to nail, uncomplicated**	24708	1.21	1421964	69.5
S62310	**Fracture of shaft of other metacarpal bone, closed**	23947	1.17	1445911	70.67
S52580	**Other fracture of lower end of radius, closed**	23438	1.15	1469349	71.82
T232	**Burn of second degree of wrist and hand**	21717	1.06	1491066	72.88
S600	**Contusion of finger(s) without damage to nail**	20991	1.03	1512057	73.9
S599	**Unspecified injury of forearm**	20624	1.01	1532681	74.91
S52500	**Colles' fracture, closed**	19627	0.96	1552308	75.87
S698	**Other specified injuries of wrist and hand**	17802	0.87	1570110	76.74
S670	**Crushing injury of thumb and other finger(s)**	17017	0.83	1587127	77.57
S62300	**Fracture of base of other metacarpal bone, closed**	16865	0.82	1603992	78.4
S5100	**Open wound of elbow, uncomplicated**	16694	0.82	1620686	79.21
S5180	**Open wound of other parts of**	16609	0.81	1637295	80.03

	forearm, uncomplicated				
T230	**Burn of unspecified degree of wrist and hand**	14824	0.72	1652119	80.75
S62800	**Fracture of other and unspecified parts of wrist and hand, closed**	14496	0.71	1666615	81.46
S681	**Traumatic amputation of other single finger (complete)(partial)**	14414	0.7	1681029	82.16
S62690	**Fracture of unspecified part of phalanx of finger, closed**	14087	0.69	1695116	82.85
S52600	**Fracture of lower end of both ulna and radius, closed**	12757	0.62	1707873	83.48
S6170	**Multiple open wounds of wrist and hand, uncomplicated**	11491	0.56	1719364	84.04
S62320	**Fracture of head of other metacarpal bone, closed**	11417	0.56	1730781	84.6
S6379	**Sprain and strain of unspecified parts of hand**	11075	0.54	1741856	85.14
S6191	**Open wound of wrist and hand part, part unspecified, complicated**	10661	0.52	1752517	85.66
S63110	**Dislocation of interphalangeal (joint) of finger, closed**	10426	0.51	1762943	86.17
S52800	**Fracture of other parts of forearm, closed**	9617	0.47	1772560	86.64
S62611	**Fracture of distal phalanx of finger, open**	8505	0.42	1781065	87.05
S601	**Contusion of finger(s) with damage to nail**	8446	0.41	1789511	87.47
S62510	**Fracture of distal phalanx, closed**	8280	0.4	1797791	87.87
S6181	**Open wound of other parts of wrist and hand, complicated**	8202	0.4	1805993	88.27
S5349	**Unspecified sprain and strain of elbow**	7621	0.37	1813614	88.64

T222	**Burn of second degree of shoulder and upper limb, except wrist and hand**	7589	0.37	1821203	89.02
T110	**Superficial injury of upper limb, level unspecified**	7523	0.37	1828726	89.38
S612	**Avulsion, finger, hand, wrist**	7310	0.36	1836036	89.74
T231	**Burn of first degree of wrist and hand**	7164	0.35	1843200	90.09
S62500	**Fracture of proximal phalanx, closed**	6896	0.34	1850096	90.43
S52000	**Fracture of olecranon process of ulna, closed**	6074	0.3	1856170	90.72
S6358	**Other sprain and strain of wrist**	5833	0.29	1862003	91.01
T220	**Burn of unspecified degree of shoulder and upper limb, except wrist and hand**	5507	0.27	1867510	91.28
S678	**Crushing injury of other and unspecified parts of wrist and hand**	5222	0.26	1872732	91.53
S63190	**Unspecified dislocation of finger, closed**	5117	0.25	1877849	91.78
S6630	**Laceration of extensor muscle and tendon of other finger at wrist and hand level**	5106	0.25	1882955	92.03
S62110	**Fracture of triquetral bone, closed**	4891	0.24	1887846	92.27
S6368	**Other sprain and strain of finger(s)**	4880	0.24	1892726	92.51
T119	**Unspecified injury of upper limb, level unspecified**	4655	0.23	1897381	92.74
S598	**Other specified injuries of forearm**	4505	0.22	1901886	92.96
T111	**Open wound of upper limb, level unspecified**	4486	0.22	1906372	93.18
S52090	**Unspecified fracture of upper end of ulna, closed**	4286	0.21	1910658	93.39
S5170	**Open wound of forearm, multiple,**	4190	0.2	1914848	93.59

	uncomplicated				
S52200	**Fracture of shaft of ulna, closed**	3828	0.19	1918676	93.78
S6111	**Open wound of finger(s) with damage to nail, complicated**	3537	0.17	1922213	93.95
S62590	**Fracture of unspecified part of phalanx, closed**	3514	0.17	1925727	94.12
S5191	**Open wound of forearm, part unspecified, complicated**	3411	0.17	1929138	94.29
S6698	**Other and unspecified injury of unspecified muscle and tendon at wrist and hand level**	3359	0.16	1932497	94.45
S680	**Traumatic amputation of thumb (complete)(partial)**	3202	0.16	1935699	94.61
T112	**Dislocation, sprain and strain of unspecified joint and ligament of upper limb, level unspecified**	3178	0.16	1938877	94.77
S62601	**Fracture of middle or proximal phalanx of finger, open**	3009	0.15	1941886	94.91
S62200	**Fracture of base of first metacarpal bone, closed**	2775	0.14	1944661	95.05
T221	**Burn of first degree of shoulder and upper limb, except wrist and hand**	2579	0.13	1947240	95.18
S52110	**Fracture of neck of radius, closed**	2547	0.12	1949787	95.3
S6610	**Laceration of flexor muscle and tendon of other finger at wrist and hand level**	2544	0.12	1952331	95.42
S5688	**Other and unspecified injury of other and unspecified muscles and tendons at forearm level**	2471	0.12	1954802	95.54
S63100	**Dislocation of metacarpophalangeal (joint) of finger, closed**	2429	0.12	1957231	95.66
S62700	**Multiple fractures of fingers, closed**	2252	0.11	1959483	95.77
S62511	**Fracture of distal phalanx, open**	2136	0.1	1961619	95.88

S607	**Multiple superficial injuries of wrist and hand**	2090	0.1	1963709	95.98
S53190	**Unspecified dislocation of elbow, closed**	2049	0.1	1965758	96.08
S5640	**Laceration of extensor muscle and tendon of other finger(s) at forearm level**	2039	0.1	1967797	96.18
S6378	**Sprain and strain of other parts of hand**	2021	0.1	1969818	96.28
S6360	**Sprain and strain of interphalangeal (joint) of finger(s)**	1997	0.1	1971815	96.38
S682	**Traumatic amputation of two or more fingers alone (complete)(partial)**	1950	0.1	1973765	96.47
S63180	**Other dislocation of finger, closed**	1850	0.09	1975615	96.56
S5181	**Open wound of other parts of forearm, complicated**	1834	0.09	1977449	96.65
S6620	**Laceration of extensor muscle and tendon of thumb at wrist and hand level**	1811	0.09	1979260	96.74
S6690	**Laceration of unspecified muscle and tendon at wrist and hand level**	1775	0.09	1981035	96.83
S62400	**Multiple fractures of base of other metacarpal bones, closed**	1732	0.08	1982767	96.91
S62691	**Fracture of unspecified part of phalanx of finger, open**	1533	0.07	1984300	96.99
S52010	**Fracture of coronoid process of ulna, closed**	1470	0.07	1985770	97.06
S6361	**Sprain and strain of metacarpophalangeal (joint) of finger(s)**	1468	0.07	1987238	97.13
S53110	**Posterior dislocation of elbow, closed**	1446	0.07	1988684	97.2
S6638	**Other and unspecified injury of extensor muscle and tendon of other**	1437	0.07	1990121	97.27

	finger at wrist and hand level				
S5348	**Other sprain and strain of elbow**	1333	0.07	1991454	97.34
S5101	**Open wound of elbow, complicated**	1263	0.06	1992717	97.4
S52700	**Multiple fractures of forearm, closed**	1215	0.06	1993932	97.46
S62290	**Fracture of unspecified site of first metacarpal bone, closed**	1214	0.06	1995146	97.52
S52300	**Fracture of shaft of radius, closed**	1203	0.06	1996349	97.58
S62370	**Fracture of multiple sites of other metacarpal bone, closed**	1159	0.06	1997508	97.63
S6171	**Multiple open wounds of wrist and hand, complicated**	1060	0.05	1998568	97.68
S5341	**Sprain and strain of ulnar collateral ligament**	1034	0.05	1999602	97.73
S6688	**Other and unspecified injury of other muscles and tendons at wrist and hand level**	1018	0.05	2000620	97.78
S62190	**Fracture of unspecified carpal bones, closed**	926	0.05	2001546	97.83
S5610	**Laceration of long flexor muscle and tendon of other finger(s) at forearm level**	912	0.04	2002458	97.87
S6680	**Laceration of other muscles and tendons at wrist and hand level**	912	0.04	2003370	97.92
S62160	**Fracture of hamate bone, closed**	892	0.04	2004262	97.96
S6440	**Laceration of digital nerve of other finger**	887	0.04	2005149	98.01
S52400	**Fracture of shafts of both ulna and radius, closed**	884	0.04	2006033	98.05
S62410	**Multiple fractures of shaft of other metacarpal bones, closed**	858	0.04	2006891	98.09
S62490	**Multiple fractures unspecified site of other metacarpal bones, closed**	840	0.04	2007731	98.13

S5648	**Other and unspecified injury of extensor muscle and tendon of other finger(s) at forearm level**	828	0.04	2008559	98.17
T233	**Burn of third degree of wrist and hand**	804	0.04	2009363	98.21
S634	**Traumatic rupture of ligament of finger at metacarpophalangeal and interphalangeal joint(s)**	784	0.04	2010147	98.25
S6371	**Sprain and strain of metacarpal (distal) (proximal)**	779	0.04	2010926	98.29
S6350	**Sprain and strain of carpal (joint) of wrist**	761	0.04	2011687	98.33
S5680	**Laceration of other and unspecified muscles and tendons at forearm level**	737	0.04	2012424	98.36
S6600	**Laceration of long flexor muscle and tendon of thumb at wrist and hand level**	681	0.03	2013105	98.39
S52080	**Other/multiple fractures of upper end of ulna, closed**	665	0.03	2013770	98.43
S62701	**Multiple fractures of fingers, open**	658	0.03	2014428	98.46
S5408	**Other and unspecified ulnar nerve injury at forearm level**	647	0.03	2015075	98.49
S62501	**Fracture of proximal phalanx, open**	637	0.03	2015712	98.52
S6618	**Other and unspecified injury of flexor muscle and tendon of other finger at wrist and hand level**	637	0.03	2016349	98.55
T234	**Corrosion of unspecified degree of wrist and hand**	623	0.03	2016972	98.58
S62470	**Multiple fractures of multiple sites of other metacarpal bones, closed**	616	0.03	2017588	98.61
T115	**Injury of unspecified muscle and tendon of upper limb, level unspecified**	598	0.03	2018186	98.64

S52900	**Fracture of forearm, part unspecified, closed**	577	0.03	2018763	98.67
S5630	**Laceration of extensor or abductor muscles and tendons of thumb at forearm level**	565	0.03	2019328	98.7
S62670	**Fracture of multiple sites of finger, closed**	558	0.03	2019886	98.73
S62180	**Fracture of other carpal bones, closed**	545	0.03	2020431	98.75
S52190	**Unspecified fracture of upper end of radius, closed**	537	0.03	2020968	98.78
S5620	**Laceration of other flexor muscle and tendon at forearm level**	523	0.03	2021491	98.8
S62130	**Fracture of trapezium bone, closed**	500	0.02	2021991	98.83
T118	**Other specified injuries of upper limb, level unspecified**	495	0.02	2022486	98.85
S697	**Multiple injuries of wrist and hand**	488	0.02	2022974	98.88
S62100	**Fracture of lunate bone, closed**	479	0.02	2023453	98.9
S63111	**Dislocation of interphalangeal (joint) of finger, open**	467	0.02	2023920	98.92
S5171	**Open wound of forearm, multiple, complicated**	433	0.02	2024353	98.94
S63030	**Dislocation of carpometacarpal (joint), closed**	431	0.02	2024784	98.97
S6670	**Laceration of multiple extensor muscles and tendons at wrist and hand level**	404	0.02	2025188	98.99
S63080	**Other dislocation of wrist, closed**	399	0.02	2025587	99
S52120	**Fracture of radius with ulna, upper end, closed**	390	0.02	2025977	99.02
S62420	**Multiple fractures of head of other metacarpal bones, closed**	378	0.02	2026355	99.04

S6448	**Other and unspecified injury of digital nerve of other finger**	371	0.02	2026726	99.06
S62120	**Fracture of pisiform bone, closed**	362	0.02	2027088	99.08
S62210	**Fracture of shaft of first metacarpal bone, closed**	362	0.02	2027450	99.1
S62591	**Fracture of unspecified part of phalanx, open**	358	0.02	2027808	99.11
S579	**Crushing injury of forearm, part unspecified**	354	0.02	2028162	99.13
S6660	**Laceration of multiple flexor muscles and tendons at wrist and hand level**	350	0.02	2028512	99.15
S62220	**Fracture of neck of first metacarpal bone, closed**	341	0.02	2028853	99.16
S6498	**Other and unspecified injury of unspecified nerves at wrist and hand level**	335	0.02	2029188	99.18
S1438	**Other and unspecified injury of brachial plexus**	333	0.02	2029521	99.2
S5658	**Other and unspecified injury of other extensor muscle and tendon at forearm level**	327	0.02	2029848	99.21
S53180	**Other dislocation of elbow, closed**	322	0.02	2030170	99.23
T223	**Burn of third degree of shoulder and upper limb, except wrist and hand**	322	0.02	2030492	99.24
S5650	**Laceration of other extensor muscle and tendon at forearm level**	319	0.02	2030811	99.26
S52601	**Fracture of lower end of both ulna and radius, open**	317	0.02	2031128	99.28
S5618	**Other and unspecified injury of long flexor muscle and tendon of other finger(s) at forearm level**	317	0.02	2031445	99.29
S6351	**Sprain and strain of radiocarpal (joint)(ligament) of wrist**	311	0.02	2031756	99.31

S53100	**Anterior dislocation of elbow, closed**	304	0.01	2032060	99.32
S52180	**Other/multiple fracture of upper end of radius, closed**	301	0.01	2032361	99.34
S62391	**Fracture of unspecified site of other metacarpal bone, open**	300	0.01	2032661	99.35
S5628	**Other and unspecified injury of other flexor muscle and tendon at forearm level**	285	0.01	2032946	99.36
S6628	**Other and unspecified injury of extensor muscle and tendon of thumb at wrist and hand level**	285	0.01	2033231	99.38
S6370	**Sprain and strain of carpometacarpal (joint) of hand**	275	0.01	2033506	99.39
S62311	**Fracture of shaft of other metacarpal bone, open**	274	0.01	2033780	99.41
T224	**Corrosion of unspecified degree of shoulder and upper limb, except wrist and hand**	267	0.01	2034047	99.42
S533	**Traumatic rupture of ulnar collateral ligament**	255	0.01	2034302	99.43
S6408	**Other and unspecified injury of ulnar nerve at wrist and hand level**	252	0.01	2034554	99.44
S63090	**Unspecified dislocation of wrist, closed**	242	0.01	2034796	99.45
S655	**Injury of blood vessel(s) of other finger**	239	0.01	2035035	99.47
S52591	**Unspecified fracture of lower end of radius, open**	236	0.01	2035271	99.48
S5498	**Other and unspecified nerve injury of unspecified nerves at forearm level**	230	0.01	2035501	99.49
S530	**Dislocation of radial head**	223	0.01	2035724	99.5
S570	**Crushing injury of elbow**	217	0.01	2035941	99.51

S52001	**Fracture of olecranon process of ulna, open**	214	0.01	2036155	99.52
S62671	**Fracture of multiple sites of finger, open**	212	0.01	2036367	99.53
S63040	**Dislocation of metacarpal (bone) proximal end, closed**	208	0.01	2036575	99.54
S4498	**Other and unspecified injury of unspecified nerve at shoulder and upper arm level**	206	0.01	2036781	99.55
S62801	**Fracture of other and unspecified parts of wrist and hand, open**	206	0.01	2036987	99.56
S6430	**Laceration of digital nerve of thumb**	206	0.01	2037193	99.57
S6400	**Laceration of ulnar nerve at wrist and hand level**	204	0.01	2037397	99.58
S659	**Injury of unspecified blood vessel at wrist and hand level**	192	0.01	2037589	99.59
S62570	**Fracture of multiple sites of thumb, closed**	190	0.01	2037779	99.6
S63000	**Dislocation of radioulnar (joint) distal, closed**	181	0.01	2037960	99.61
S52581	**Other fracture of lower end of radius, open**	175	0.01	2038135	99.62
S5428	**Other and unspecified radial nerve injury at forearm level**	175	0.01	2038310	99.63
S5638	**Other and unspecified injury of extensor or abductor muscles and tendons of thumb at forearm level**	174	0.01	2038484	99.64
S63200	**Multiple dislocations of fingers, closed**	172	0.01	2038656	99.64
S62321	**Fracture of head of other metacarpal bone, open**	171	0.01	2038827	99.65
S52401	**Fracture of shafts of both ulna and radius, open**	164	0.01	2038991	99.66

S651	**Injury of radial artery at wrist and hand level**	155	0.01	2039146	99.67
S6608	**Other and unspecified injury of long flexor muscle and tendon of thumb at wrist and hand level**	154	0.01	2039300	99.67
T236	**Corrosion of second degree of wrist and hand**	150	0.01	2039450	99.68
T113	**Injury of unspecified nerve of upper limb, level unspecified**	149	0.01	2039599	99.69
S551	**Injury of radial artery at forearm level**	148	0.01	2039747	99.7
S62150	**Fracture of capitate bone, closed**	143	0.01	2039890	99.7
S62301	**Fracture of base of other metacarpal bone, open**	142	0.01	2040032	99.71
S6490	**Laceration of unspecified nerve at wrist and hand level**	141	0.01	2040173	99.72
S52020	**Monteggia's fracture, closed**	137	0.01	2040310	99.72
S578	**Crushing injury of other parts of forearm**	132	0.01	2040442	99.73
S5400	**Laceration of ulnar nerve at forearm level**	124	0.01	2040566	99.74
S5600	**Laceration of flexor muscle and tendon of thumb at forearm level**	118	0.01	2040684	99.74
S52801	**Fracture of other parts of forearm, open**	117	0.01	2040801	99.75
S597	**Multiple injuries of forearm**	114	0.01	2040915	99.75
S52201	**Fracture of shaft of ulna, open**	111	0.01	2041026	99.76
S62140	**Fracture of trapezoid bone, closed**	111	0.01	2041137	99.76
S4408	**Other and unspecified injury of ulnar nerve at upper arm level**	106	0.01	2041243	99.77
S5418	**Other and unspecified median nerve injury at forearm level**	103	0.01	2041346	99.77

S63191	**Unspecified dislocation of finger, open**	103	0.01	2041449	99.78
T235	**Corrosion of first degree of wrist and hand**	103	0.01	2041552	99.79
S559	**Injury of unspecified blood vessel at forearm level**	102	0	2041654	99.79
S6438	**Other and unspecified injury of digital nerve of thumb**	102	0	2041756	99.8
S470	**Crushing injury of shoulder region**	101	0	2041857	99.8
S6420	**Laceration of radial nerve at wrist and hand level**	99	0	2041956	99.8
T100	**Fracture of upper limb, level unspecified, closed**	97	0	2042053	99.81
T226	**Corrosion of second degree of shoulder and upper limb, except wrist and hand**	93	0	2042146	99.81
S52091	**Unspecified fracture of upper end of ulna, open**	90	0	2042236	99.82
S5340	**Sprain and strain of radial collateral ligament**	90	0	2042326	99.82
S6410	**Laceration of median nerve at wrist and hand level**	90	0	2042416	99.83
S6418	**Other and unspecified injury of median nerve at wrist and hand level**	90	0	2042506	99.83
S650	**Injury of ulnar artery at wrist and hand level**	87	0	2042593	99.84
S6428	**Other and unspecified injury of radial nerve at wrist and hand level**	86	0	2042679	99.84
S473	**Crushing injury of upper arm**	83	0	2042762	99.84
S52501	**Colles' fracture, open**	83	0	2042845	99.85
S654	**Injury of blood vessel(s) of thumb**	81	0	2042926	99.85
S550	**Injury of ulnar artery at forearm**	80	0	2043006	99.86

	level				
S6658	**Other and unspecified injury of intrinsic muscle and tendon of other finger at wrist and hand level**	79	0	2043085	99.86
S63181	**Other dislocation of finger, open**	78	0	2043163	99.86
S53130	**Lateral dislocation of elbow, closed**	77	0	2043240	99.87
S5670	**Laceration of multiple muscles and tendons at forearm level**	77	0	2043317	99.87
S6678	**Other and unspecified of multiple extensor muscles and tendons at wrist and hand level**	76	0	2043393	99.88
S5608	**Other and unspecified injury of flexor muscle and tendon of thumb at forearm level**	72	0	2043465	99.88
S5678	**Other and unspecified injury of multiple muscles and tendons at forearm level**	72	0	2043537	99.88
S6480	**Laceration of other nerves at wrist and hand level**	70	0	2043607	99.89
S658	**Injury of other blood vessels at wrist and hand level**	70	0	2043677	99.89
T225	**Corrosion of first degree of shoulder and upper limb, except wrist and hand**	70	0	2043747	99.89
S52101	**Fracture of head of radius, open**	68	0	2043815	99.9
S633	**Traumatic rupture of ligament of wrist and carpus**	68	0	2043883	99.9
S6668	**Other and unspecified injury of multiple flexor muscles and tendons at wrist and hand level**	64	0	2043947	99.9
S62571	**Fracture of multiple sites of thumb, open**	62	0	2044009	99.91
S6640	**Laceration of intrinsic muscle and tendon of thumb at wrist and hand**	58	0	2044067	99.91

	level				
S6488	**Other and unspecified injury of other nerves at wrist & hand**	56	0	2044123	99.91
S683	**Combined traumatic amputation of (part of) finger(s) with other parts of wrist and hand**	56	0	2044179	99.91
S689	**Traumatic amputation of wrist and hand, level unspecified**	55	0	2044234	99.92
S52701	**Multiple fractures of forearm, open**	54	0	2044288	99.92
S5410	**Laceration of median nerve at forearm level**	52	0	2044340	99.92
S6648	**Other and unspecified injury of intrinsic muscle and tendon of thumb at wrist and hand level**	52	0	2044392	99.92
S5420	**Laceration of radial nerve at forearm level**	49	0	2044441	99.93
S62001	**Fracture of navicular [scaphoid] bone of hand, open**	47	0	2044488	99.93
S62401	**Multiple fractures of base of other metacarpal bones, open**	47	0	2044535	99.93
S52901	**Fracture of forearm, part unspecified, open**	45	0	2044580	99.93
S63101	**Dislocation of metacarpophalangeal (joint) of finger, open**	45	0	2044625	99.94
S62270	**Fracture of multiple sites of first metacarpal bones, closed**	42	0	2044667	99.94
S6650	**Laceration of intrinsic muscle and tendon of other finger at wrist and hand level**	41	0	2044708	99.94
S4488	**Other and unspecified injury of other nerves at shoulder and upper arm level**	39	0	2044747	99.94
S52301	**Fracture of shaft of radius, open**	38	0	2044785	99.94

S62201	**Fracture of base of first metacarpal bone, open**	38	0	2044823	99.94
S4438	**Other and unspecified injury of axillary nerve**	37	0	2044860	99.95
S62291	**Fracture of unspecified site of first metacarpal bone, open**	37	0	2044897	99.95
S688	**Traumatic amputation of other parts of wrist and hand**	36	0	2044933	99.95
S552	**Injury of vein at forearm level**	34	0	2044967	99.95
S6372	**Midcarpal sprain and strain of hand**	34	0	2045001	99.95
S5490	**Laceration of unspecified nerve at forearm level**	32	0	2045033	99.96
S62371	**Fracture of multiple sites of other metacarpal bone, open**	32	0	2045065	99.96
S53120	**Medial dislocation of elbow, closed**	31	0	2045096	99.96
S5488	**Other and unspecified nerve injury of other nerves at forearm level**	28	0	2045124	99.96
S62471	**Multiple fractures of multiple sites of other metacarpal bones, open**	28	0	2045152	99.96
S4428	**Other and unspecified injury of radial nerve at upper arm level**	27	0	2045179	99.96
S62411	**Multiple fractures of shaft of other metacarpal bones, open**	27	0	2045206	99.96
S52121	**Fracture of radius with ulna, upper end, open**	26	0	2045232	99.96
S532	**Traumatic rupture of radial collateral ligament**	26	0	2045258	99.97
S478	**Crushing injury of other specified parts of shoulder & upper arm**	24	0	2045282	99.97
S6478	**Other specified injury of multiple nerves at wrist and hand level**	24	0	2045306	99.97
S62111	**Fracture of triquetral bone, open**	23	0	2045329	99.97

S62211	**Fracture of shaft of first metacarpal bone, open**	23	0	2045352	99.97
S63020	**Dislocation of midcarpal (joint), closed**	23	0	2045375	99.97
S4400	**Laceration of ulnar nerve at upper arm level**	22	0	2045397	99.97
S5342	**Sprain and strain of radiohumeral (joint)**	21	0	2045418	99.97
S53191	**Unspecified dislocation of elbow, open**	20	0	2045438	99.97
S684	**Traumatic amputation of hand at wrist level**	20	0	2045458	99.98
S4418	**Other and unspecified injury of median nerve at upper arm level**	19	0	2045477	99.98
S52021	**Monteggia's fracture, open**	19	0	2045496	99.98
S62491	**Multiple fractures unspecified site of other metacarpal bones, open**	19	0	2045515	99.98
S558	**Injury of other blood vessels at forearm level**	17	0	2045532	99.98
S63010	**Dislocation of radiocarpal (joint), closed**	17	0	2045549	99.98
S6470	**Laceration of multiple nerves at wrist and hand level**	17	0	2045566	99.98
T114	**Injury of unspecified blood vessel of upper limb, level unspecified**	17	0	2045583	99.98
S557	**Injury of multiple blood vessels at forearm level**	16	0	2045599	99.98
S657	**Injury of multiple blood vessels at wrist and hand level**	15	0	2045614	99.98
S52081	**Other/multiple fractures of upper end of ulna, open**	14	0	2045628	99.98
S53111	**Posterior dislocation of elbow, open**	14	0	2045642	99.98

S581	**Traumatic amputation at level between elbow and wrist**	14	0	2045656	99.99
S62221	**Fracture of neck of first metacarpal bone, open**	14	0	2045670	99.99
S63201	**Multiple dislocations of fingers, open**	13	0	2045683	99.99
S477	**Crushing injury of multiple sites of shoulder & upper arm**	12	0	2045695	99.99
T237	**Corrosion of third degree of wrist and hand**	12	0	2045707	99.99
S5430	**Laceration of cutaneous sensory nerve at forearm level**	10	0	2045717	99.99
S5438	**Other and unspecified cutaneous sensory nerve injury at forearm level**	10	0	2045727	99.99
S62131	**Fracture of trapezium bone, open**	10	0	2045737	99.99
S489	**Traumatic amputation of shoulder and upper arm, level unspecified**	9	0	2045746	99.99
S471	**Crushing injury of scapular region**	8	0	2045754	99.99
S53181	**Other dislocation of elbow, open**	8	0	2045762	99.99
S5343	**Sprain and strain of ulnohumeral (joint)**	8	0	2045770	99.99
S589	**Traumatic amputation of forearm, level unspecified**	8	0	2045778	99.99
T227	**Corrosion of third degree of shoulder and upper limb, except wrist and hand**	8	0	2045786	99.99
S52191	**Unspecified fracture of upper end of radius, open**	7	0	2045793	99.99
S5478	**Other and unspecified injury of multiple nerves at forearm level**	7	0	2045800	99.99
S580	**Traumatic amputation at elbow level**	7	0	2045807	99.99
S62181	**Fracture of other carpal bones, open**	7	0	2045814	99.99

S4410	**Laceration of median nerve at upper arm level**	6	0	2045820	99.99
S4478	**Other and unspecified injury of multiple nerves at shoulder and upper arm level**	6	0	2045826	99.99
S52011	**Fracture of coronoid process of ulna, open**	6	0	2045832	99.99
S5480	**Laceration of other nerves at forearm level**	6	0	2045838	99.99
S62421	**Multiple fractures of head of other metacarpal bones, open**	6	0	2045844	99.99
T116	**Traumatic amputation of upper limb, level unspecified**	6	0	2045850	100
S1430	**Laceration of brachial plexus**	5	0	2045855	100
S52111	**Fracture of neck of radius, open**	5	0	2045860	100
S5470	**Laceration of multiple nerves at forearm level**	5	0	2045865	100
S62121	**Fracture of pisiform bone, open**	5	0	2045870	100
S62161	**Fracture of hamate bone, open**	5	0	2045875	100
S62191	**Fracture of unspecified carpal bones, open**	5	0	2045880	100
S63091	**Unspecified dislocation of wrist, open**	5	0	2045885	100
S653	**Injury of deep palmar arch**	5	0	2045890	100
S4420	**Laceration of radial nerve at upper arm level**	4	0	2045894	100
S4458	**Other specified injury of cutaneous sensory nerve at shoulder and upper arm level**	4	0	2045898	100
S480	**Traumatic amputation at shoulder joint**	4	0	2045902	100
S53101	**Anterior dislocation of elbow, open**	4	0	2045906	100

S62101	**Fracture of lunate bone, open**	4	0	2045910	100
S62151	**Fracture of capitate bone, open**	4	0	2045914	100
S4490	**Laceration of unspecified nerve at shoulder and upper arm level**	3	0	2045917	100
S53131	**Lateral dislocation of elbow, open**	3	0	2045920	100
S62271	**Fracture of multiple sites of first metacarpal bones, open**	3	0	2045923	100
S652	**Injury of superficial palmar arch**	3	0	2045926	100
T101	**Fracture of upper limb, level unspecified, open**	3	0	2045929	100
T1421	**Fracture of unspecified body region, open**	3	0	2045932	100
S4448	**Other and unspecified injury of musculocutaneous nerve**	2	0	2045934	100
S472	**Crushing injury of axillary region**	2	0	2045936	100
S53121	**Medial dislocation of elbow, open**	2	0	2045938	100
S63001	**Dislocation of radioulnar (joint) distal, open**	2	0	2045940	100
S63031	**Dislocation of carpometacarpal (joint), open**	2	0	2045942	100
S63041	**Dislocation of metacarpal (bone) proximal end, open**	2	0	2045944	100
S4430	**Laceration of axillary nerve**	1	0	2045945	100
S4440	**Laceration of musculocutaneous nerve**	1	0	2045946	100
S4470	**Laceration of multiple nerves at shoulder and upper arm level**	1	0	2045947	100
S52181	**Other/multiple fracture of upper end of radius, open**	1	0	2045948	100
S62141	**Fracture of trapezoid bone, open**	1	0	2045949	100
S63081	**Other dislocation of wrist, open**	1	0	2045950	100

Appendix 2.2 Algorithm for Inclusion and Exlcusion Of Episodes of Hand Trauma Based on MRDx or anyDx:

Exclude as MRDx or anyDx:

Head injury S00-S09

Neck S10-S14.2, S14.4-19

Thorax S20-29

Lower back, etc S30-39

Hip-thigh: S70-79

Knee-lower leg: S80-89

Foot: S90-99

Multiple body regions: T00-T07

Unspecified parts: T08-09.3, T09.5-09.9

Unspecified lower limb: T12-T13.9

Foreign body: T15-19

Burns Trunk: T20-T21.7

Burns to lower extremity: T24.0-T25.7

Frostbite: T33-35

Poisoning: T36-50

Toxic substances: T51-65

Other external causes: T66-73.9, T75-78.9

Complications of surgery: T82—83.9, T85-86.9

Complication of lower extremtiny amputation: T87.1

Sequelae of injury: T90-T91.9, T93.0-T94.1,T95.0-95.1, T95.3-95.9, T96-98.3

Include as MRDx or anyDX:

Injury to brachial plexus: S14.3

Shoulder S40-S49

Elbow and upper arm S50-S59

Hand and Wrist S60-S69

Unspecified nerve/trunk/plexus T09.4

Unspecified upper limb fracture: T10-11.9

Unspecified body region injury type: T14.0-T14-9

Burns upper limb, hand and wrist: T22.0-T23.7

The following can be secondary diagnosis (eg. ICD2-10) so do not need to exclude

Neglect/abuse: T74.0-74.9

Early complications of trauma: T79-T79.9

Complications of surgery: T80-T81.9

Complications of internal fixation device: T84.0-84.9

Complications of reattachment:T87, T87.3-87.6

Complication of anesthesia: T88-T88.9

Sequelae of injury: T92.0-T92.9, T95.2

Appendix 2.3: Procedure codes and description from DAD and NACRS-SDS databases.

DAD / NACRS-SDS Procedure Code	Procedure Description
1TV74LANW	**Fixation, radius and ulna open approach no tissue used using plate, screw**

1TH80WUNW	**Repair, tendons of the arm [around shoulder] using tenodesis with screw fixation [e.g. tendon with a bone plug fixed to bone with screw] Simple repair (without graft or transfer involved)**
1TV87LAPM	**Excision partial, radius and ulna no tissue used (for closure of defect) using endoprosthesis [radial or humeral head]**
1UB74LAKDA	**Fixation, wrist joint open approach with bone autograft using wire, mesh, staple**
1UF74LAKDA	**Fixation, other metacarpal bones open approach with bone autograft using wire, staple**
1UF80LA	**Repair, other metacarpal bones no tissue used (for repair) no device used**
1UI93LAXXE	**Amputation, first phalanx of hand using local flap [e.g. V-Y plasty]**
1UM75LAKD	**Fusion, first interphalangeal joint of hand open approach using wire, tension band**
1VX52LA	**Drainage, soft tissue of leg using open (incisional) approach**
1YU87LAXXA	**Excision partial, skin of hand open [excisional] approach using full thickness autograft**
1BN87LAXXQ	**Excision partial, nerve(s) of forearm and wrist end to end [rejoining] technique (e.g. suture, glue) combined transposition of nerves with a nerve autograft**
1BQ87WF	**Excision partial, nerve(s) of digit of hand no rejoining [of nerve ends] nerve end buried**
1JU51LA	**Occlusion, veins of arm NEC using open approach**
1UC79HAKC	**Repair by increasing size, distal radioulnar joint and carpal joints and bones no tissue used in lengthening [or distracting] using external fixator device [for distraction]**
1TX87LAXXA	**Excision partial, soft tissue of arm NEC using open approach and autograft [e.g. fascia or skin] (to close surgical defect)**
1UB55JAGX	**Removal of device, wrist joint of device NEC using external approach**
1UB87GB	**Excision partial, wrist joint endoscopic [arthroscopic] approach, synovectomy [dissection] alone**
1UF55LANW	**Removal of device, other metacarpal bones of plate/screw using open approach**

1TA80LA	**Repair, shoulder joint open approach using simple apposition technique only [e.g. suturing]**
1UB52WK	**Drainage, wrist joint using open incisional approach [e.g. bursotomy]**
1UB80LAXXA	**Repair, wrist joint open approach using autograft [e.g. bone, interpositional fascia lata, muscle graft, rolled ôanchovyö graft]**
1UE73JA	**Reduction, first metacarpal bone using closed (external) approach**
1UI73LA	**Reduction, first phalanx of hand using open approach**
1UB74DANW	**Fixation, wrist joint endoscopic [arthroscopic] approach fixation device alone using plate, screw**
1UB74LANWQ	**Fixation, wrist joint open approach with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1UC75LAKD	**Fusion, distal radioulnar joint and carpal joints and bones fixation device [alone] using wire, staple**
1UF93LAXXE	**Amputation, other metacarpal bones using local flap [e.g. myoplasty or myodesis] (for closure of stump)**
1UI56LA	**Removal of foreign body, first phalanx of hand using open approach**
1UK53LAPM	**Implantation of internal device, other interphalangeal joints of hand of uncemented single-component prosthetic device using open approach**
1UB53LAPM	**Implantation of internal device, wrist joint uncemented single-component prosthetic device [e.g. styloid process of radius]**
1UB80DA	**Repair, wrist joint endoscopic [arthroscopic] approach using simple apposition technique only [e.g. suturing]**
1UJ93LAXXF	**Amputation, other phalanx of hand using free flap [e.g. toe-to-finger flap]**
1UK55HAKD	**Removal of device, other interphalangeal joints of hand of wire/staple using percutaneous approach**
1UM73LA	**Reduction, first interphalangeal joint of hand using open approach**
1UJ55LANW	**Removal of device, other phalanx of hand of plate/screw using open approach**
1UJ74LAKDN	**Fixation, other phalanx of hand open approach with synthetic tissue [bone cement, paste] using wire, staple, tension band**
1UK80LAKDA	**Repair, other interphalangeal joints of hand joint repair alone with autograft**

	[e.g. bone, interpositional tendon, fascia] using wire, staple, tension band
1UK80LAXXA	**Repair, other interphalangeal joints of hand joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] no device used (for repair)**
1UM74LANW	**Fixation, first interphalangeal joint of hand using open approach and screw**
1UM87LA	**Excision partial, first interphalangeal joint of hand using open approach**
1US80WUNW	**Repair, extensor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] simple repair (without graft or transfer involved)**
1UY80LAXXF	**Repair, soft tissue of the wrist and hand using open approach and free flap**
1JM87LAXXA	**Excision partial, arteries of arm NEC using autograft open approach**
1JU80LAXXA	**Repair, veins of arm NEC using open approach with autograft**
1TQ72WJ	**Release, muscles of the forearm [around elbow] using excisional technique [e.g. fasciectomy]**
1TV74LAKDQ	**Fixation, radius and ulna open approach with combined sources of tissue [e.g. bone graft, cement/paste] using wire, mesh, staple**
1UB03JAFG	**Immobilization, wrist joint using binding device (e.g. restrictive dressing, taping)**
1UB74LANVA	**Fixation, wrist joint open approach with bone autograft using pin, nail**
1UE74LANV	**Fixation, first metacarpal bones open approach fixation device alone using pin, nail**
1UG87WJ	**Excision partial, other metacarpophalangeal joint(s) using synovectomy dissection only**
1UG93LAXXE	**Amputation, other metacarpophalangeal joint(s) using local flap myoplasty or myodesis (for closure of stump)**
1TM74LAKDN	**Fixation, elbow joint open approach with synthetic tissue[e.g. bone cement, or paste] using wire, mesh, staple**
1TV74LANVQ	**Fixation, radius and ulna open approach with combined sources of tissue [e.g. bone graft, cement/paste] using pin, nail**
1UB52HA	**Drainage, wrist joint using percutaneous (needle) approach for aspiration**
1UB53LAPN	**Implantation of internal device, wrist joint uncemented dual-component prosthetic device [e.g. proximal radius and ulnar head with or without**

	scaphoid or lunate component]
1UC89LA	**Excision total, distal radioulnar joint and carpal joints and bones using open approach**
1UM80LAKD	**Repair, first interphalangeal joint of hand, joint repair alone no tissue used (for repair) using wire, staple, tension band**
1TX87LAXXE	**Excision partial, soft tissue of arm NEC using open approach and local transposition flap [e.g. advancement muscle or Z-plasty skin flap] (to close surgical defect)**
1UC80LAXXE	**Repair, distal radioulnar joint and carpal joints and bones open approach using local tendon transfer [rebalancing]**
1UH73LA	**Reduction, first metacarpophalangeal joint using open approach**
1UI93LAXXA	**Amputation, first phalanx of hand using autograft [e.g. full-thickness skin graft or bone graft] (for closure of stump)**
1UK80LANW	**Repair, other interphalangeal joints of hand joint repair alone no tissue used (for repair) using screw, plate and screw**
1UK80VJKD	**Repair, other interphalangeal joints of hand joint repair with phalangeal osteotomy (for realigning joint) no tissue used (for repair) using wire, staple, tension band**
1UM73JA	**Reduction, first interphalangeal joint of hand using closed (external) approachh**
1UM74LANV	**Fixation, first interphalangeal joint of hand using open approach and pin or nail**
1UU53LASL	**Implantation of internal device, tendons of thumb [Pollicis tendons] of spacer device [e.g. Silastic rod] (with or without wire or screw) using open approach**
1UJ74LALQ	**Fixation, other phalanx of hand open approach fixation device alone using intramedullary nail**
1US58LAXXA	**Procurement, extensor tendons of finger [excludes thumb] of tendon autograft using open approach**
1VD58LAXXA	**Procurement, muscles of hip and thigh of muscle (or fascia) graft using open approach**
1TV56LA	**Removal of foreign body, radius and ulna using open approach**

1UE82LAKD	**Reattachment, first metacarpal bone using wire/staple fixation with apposition technique**
1UI80LA	**Repair, first phalanx of hand no tissue used (for repair) no device used**
1UI82LA	**Reattachment, first phalanx of hand using simple apposition technique [e.g. suture]**
1UK74HANW	**Fixation, other interphalangeal joints of hand using percutaneous (closed) approach and plate/screw**
1UT80WUXXE	**Repair, flexor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with tendon transfer for realignment [e.g. advancement, transposition]**
1UU80LAXXQ	**Repair, tendons of thumb [Pollicis tendons] using apposition technique [e.g. tendon sutured to tendon] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UB74LANWK	**Fixation, wrist joint open approach with bone homograft using plate, screw**
1UC80LAXXN	**Repair, distal radioulnar joint and carpal joints and bones open approach using synthetic tissue [e.g. mesh, gortex, silastic sheath]**
1UG72LA	**Release, other metacarpophalangeal joint(s) using open (incisional) approach**
1UG75LAKD	**Fusion, other metacarpophalangeal joint(s) joint fusion alone no tissue used (for fusion) using wire, staple, tension band**
1UH74LANW	**Fixation, first metacarpophalangeal joint open approach, fixation device alone using plate, screw**
1UJ71LAXXE	**Division, other phalanx of hand division involving skin and soft tissue only (simple syndactyly) using local flap [e.g. volar, dorsal]**
1UJ80LAKDA	**Repair, other phalanx of hand using autograft [e.g. bone peg] using wire, staple**
1UK55LANV	**Removal of device, other interphalangeal joints of hand of pin/nail using open approach**
1UY87LAXXA	**Excision partial, soft tissue of the wrist and hand using open approach and autograft [e.g. fascia or skin] (for closure of defect)**
1TV82LANW	**Reattachment, radius and ulna using open approach and plate/screw fixation with apposition technique [e.g. suturing]**
1UB74LAKDN	**Fixation, wrist joint open approach with synthetic tissue [e.g. bone cement,**

	or paste] using wire, mesh, staple
1UF93LAXXA	**Amputation, other metacarpal bones using skin graft (for closure of stump)**
1UG80LANW	**Repair, other metacarpophalangeal joint(s) joint repair alone no tissue used (for repair) using screw, plate and screw**
1UI80LAKD	**Repair, first phalanx of hand no tissue used (for repair) using wire, staple**
1UK53LAQD	**Implantation of internal device, other interphalangeal joints of hand of single-component prosthetic device with (additional) wire fixation (for stabilization) using open approach**
1US80LAXXQ	**Repair, extensor tendons of finger [excludes thumb] using apposition technique [e.g. tendon sutured to tendon] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UT80LAXXN	**Repair, flexor tendons of finger [excludes thumb] using apposition technique [e.g. tendon sutured to tendon] with synthetic tissue [e.g. gortex, mesh]**
1UU80WUNW	**Repair, tendons of thumb [Pollicis tendons] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] simple repair (without graft or transfer involved)**
1VD58LAXXF	**Procurement, muscles of hip and thigh of free flap using open approach**
1BM80UH	**Repair, nerve(s) of upper arm and elbow using interfascicular [split] repair [rejoining] technique**
1BM87LAXXQ	**Excision partial, nerve(s) of upper arm and elbow end-to-end [rejoining] technique (e.g. suture, glue) combined transposition of nerves with a nerve autograft**
1BP87LAXXA	**Excision partial, nerve(s) of hand end to end suture [rejoining] technique nerve autograft (to replace lost length)**
1SY58LAXXF	**Procurement, muscles of the chest and abdomen of free flap**
1TQ58LAXXF	**Procurement, muscles of the forearm [around elbow] free flap using open approach**
1TS80LAXXE	**Repair, tendons of the forearm [around elbow] using apposition technique [e.g. tendon sutured to tendon] with tendon transfer for realignment, [e.g. advancement, transposition]**
1TV58LAXXK	**Procurement, radius and ulna of bone graft (from deceased donor) using open approach**
1TV80LANWK	**Repair, radius and ulna with bone homograft using plate, screw**

1UB75LANWA	**Fusion, wrist joint with bone autograft using plate, screw**
1UB80LAXXE	**Repair, wrist joint open approach using local tendon transfer [rebalancing]**
1UC75LANW	**Fusion, distal radioulnar joint and carpal joints and bones fixation device [alone] using plate, screw**
1UH74HANV	**Fixation, first metacarpophalangeal joint percutaneous approach [closed], fixation device alone using pin, nail**
1UI55LAKD	**Removal of device, first phalanx of hand of wire/staple using open approach**
1UK80LANV	**Repair, other interphalangeal joints of hand joint repair alone no tissue used (for repair) using pin, nail**
1UV80WUNW	**Repair, tendons of wrist and hand using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] simple repair (without graft or transfer involved)**
1TS58LAXXA	**Procurement, tendons of the forearm [around elbow] of tendon autograft using open approach**
1TS80WUXXE	**Repair, tendons of the forearm [around elbow] using tenodesis technique [e.g. tendon looped or sutured to or through bone] with tendon transfer for realignment, [e.g. advancement, transposition]**
1TV80LANWN	**Repair, radius and ulna with synthetic tissue [e.g. bone cement, paste] using plate, screw**
1TV83LAXXA	**Transfer, radius and ulna using open approach and bone autograft**
1TV87LANW	**Excision partial, radius and ulna no tissue used (for closure of defect) using screw, plate and screw**
1TV93LA	**Amputation, radius and ulna using simple apposition technique [e.g. suturing] (for closure of stump)**
1TX56JA	**Removal of foreign body, soft tissue of arm NEC using external approach (for simple extraction)**
1UF56LA	**Removal of foreign body, other metacarpal bones using open approach**
1UF74LALQ	**Fixation, other metacarpal bones open approach fixation device alone using intramedullary nail**
1UG74LAKDA	**Fixation, other metacarpophalangeal joint(s) open approach, with bone autograft using wire, staple, tension band**
1UG80LANV	**Repair, other metacarpophalangeal joint(s) joint repair alone no tissue used**

	(for repair) using pin, nail
1UG93LAXXA	**Amputation, other metacarpophalangeal joint(s) using skin graft (for closure of stump)**
1UI93LAXXG	**Amputation, first phalanx of hand using pedicled transposition flap [e.g. finger rotation flap]**
1UJ74HALQ	**Fixation, other phalanx of hand percutaneous approach [e.g. with closed or no reduction] fixation device alone using intramedullary nail**
1UJ74HANW	**Fixation, other phalanx of hand percutaneous approach [e.g. with closed or no reduction] fixation device alone using plate, screw**
1UK55LANW	**Removal of device, other interphalangeal joints of hand of screw using open approach**
1UT80WUXXA	**Repair, flexor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with autograft [e.g. tendon, fascia]**
1UT80WUXXN	**Repair, flexor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with synthetic tissue [e.g. gortex, mesh]**
1TS80LAXXA	**Repair, tendons of the forearm [around elbow] using apposition technique [e.g. tendon sutured to tendon] with autograft [e.g. tendon, fascia]**
1UB74HAKDN	**Fixation, wrist joint using percutaneous approach [e.g. with closed reduction or no reduction] using wire, mesh, staple with synthetic tissue [e.g. bone cement or paste]**
1UC55LANW	**Removal of device, distal radioulnar joint and carpal joints and bones of plate/screw using open approach**
1UC74LAKDN	**Fixation, distal radioulnar joint and carpal joints and bones open approach with synthetic tissue [bone cement, paste] using wire, staple**
1UC75LANWA	**Fusion, distal radioulnar joint and carpal joints and bones with bone autograft using plate, screw**
1UF74HANW	**Fixation, other metacarpal bones percutaneous approach [e.g. with closed or no reduction] fixation device alone using plate, screw**
1UI74LAKDA	**Fixation, first phalanx of hand open approach with bone autograft using wire, staple, tension band**
1UJ87LAXXQ	**Excision partial, other phalanx of hand using open excisional approach and combined sources of tissue**

1UK80LANWA	**Repair, other interphalangeal joints of hand joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using screw, plate and screw**
1UU80LAXXN	**Repair, tendons of thumb [Pollicis tendons] using apposition technique [e.g. tendon sutured to tendon] with synthetic tissue [e.g. gortex, mesh]**
1VA80LA	**Repair, hip joint open approach using simple apposition technique only [e.g. suturing]**
1YT56JA	**Removal of foreign body, skin of arm using external approach [for simple extraction]**
1TV80LAXXN	**Repair, radius and ulna with synthetic tissue [e.g. bone cement, paste] No device used (for repair)**
1UB74LANVN	**Fixation, wrist joint open approach with synthetic tissue [e.g. bone cement, or paste] using pin, nail**
1UC74LANVA	**Fixation, distal radioulnar joint and carpal joints and bones open approach with bone autograft using pin, nail**
1UC80LANWA	**Repair, distal radioulnar joint and carpal joints and bones open approach with screw/plate device using autograft [e.g. bone, interpositional fascia lata, tendon graft, rolled anchovy graft]**
1UE73LA	**Reduction, first metacarpal bone using open approach**
1UG53LAPN	**Implantation of internal device, other metacarpophalangeal joint(s) of uncemented dual-component prosthetic device using open approach**
1UH80LANW	**Repair, first metacarpophalangeal joint, joint repair alone no tissue used (for repair) using screw, plate and screw**
1UI55LANV	**Removal of device, first phalanx of hand of pin/nail using open approach**
1UT80LAXXQ	**Repair, flexor tendons of finger [excludes thumb] using apposition technique [e.g. tendon sutured to tendon] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UU80WUXXA	**Repair, tendons of thumb [Pollicis tendons] using tenodesis technique [tendon looped or sutured to or through bone] with autograft [e.g. tendon, fascia]**
1UV80WUXXA	**Repair, tendons of wrist and hand using tenodesis technique [tendon looped or sutured to or through bone] with autograft [e.g. tendon, fascia]**
1TK93LA	**Amputation, humerus using simple apposition technique [e.g. suturing] (for closure of stump)**

1TS80WUXXA	**Repair, tendons of the forearm [around elbow] using tenodesis technique [e.g. tendon looped or sutured to or through bone] with autograft [e.g. tendon, fascia]**
1TV74LANVK	**Fixation, radius and ulna open approach with bone homograft using pin, nail**
1TV80LANVA	**Repair, radius and ulna with autograft [e.g. bone, tendon] using pin, nail**
1UC74HANW	**Fixation, distal radioulnar joint and carpal joints and bones percutaneous approach [e.g. with closed or no reduction] fixation device alone using plate, screw**
1UC74LANWQ	**Fixation, distal radioulnar joint and carpal joints and bones with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1UC79LAKD	**Repair by increasing size, distal radioulnar joint and carpal joints and bones no tissue used in lengthening [or distracting] using wire, staple**
1UE55LAKD	**Removal of device, first metacarpal bone of wire/staple/tension band using open approach**
1UF82LANW	**Reattachment, other metacarpal bones using plate/screw fixation with apposition technique**
1UF87LAXXA	**Excision partial, other metacarpal bones with bone autograft (to close defect), no device used**
1UG74LANWA	**Fixation, other metacarpophalangeal joint(s) open approach with bone autograft using plate, screw**
1UJ56JA	**Removal of foreign body, other phalanx of hand using external (manual extraction) approach**
1UJ71LAXXQ	**Division, other phalanx of hand division involving skin and soft tissue only (simple syndactyly) using combination of local flap and skin autograft**
1UJ80LAXXF	**Repair, other phalanx of hand using free flap [e.g. toe-to-finger flap] no device used**
1UM80LANV	**Repair, first interphalangeal joint of hand, joint repair alone no tissue used (for repair) using pin, nail**
1US80WUXXA	**Repair, extensor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with autograft [e.g. tendon, fascia]**
1BM87UHXXE	**Excision partial, nerve(s) of upper arm and elbow interfascicular split repair [rejoining] technique transposition of nerves [e.g. crossover]**

1BQ80LAW3	**Repair, nerve(s) of digit of hand using fibrin glue [rejoining] technique**
1BQ87LAXXN	**Excision partial, nerve(s) of digit of hand, no rejoining (of nerve ends) nerve end(s) wrapped or bridged using synthetic tissue [e.g. neural tube]**
1TK93LAXXE	**Amputation, humerus using local flap [e.g. myoplasty, osteoperiosteal flap or myodesis] (for closure of stump)**
1TQ87LAXXF	**Excision partial, muscles of the forearm [around elbow] using free flap [e.g. myocutaneous free flap] (for closure of defect)**
1TV79LAMG	**Repair by increasing size, radius and ulna using circular frame distraction device [e.g. Ilizarov]**
1TV80LANWQ	**Repair, radius and ulna with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1TV83LAXXN	**Transfer, radius and ulna using open approach and synthetic tissue [e.g. bone cement, paste]**
1TV87LANWA	**Excision partial, radius and ulna with bone autograft using screw, plate and screw**
1TV93LAXXE	**Amputation, radius and ulna using local flap [e.g. myoplasty, osteoperiosteal flap or myodesis] (for closure of stump)**
1UB52WJ	**Drainage, wrist joint using open excisional approach [e.g. bursectomy]**
1UB93LA	**Amputation, wrist joint using simple apposition technique [e.g. suturing] (for closure of stump)**
1UC75LAKDA	**Fusion, distal radioulnar joint and carpal joints and bones with bone autograft using wire, staple**
1UF74LAKDN	**Fixation, other metacarpal bones open approach with synthetic tissue [e.g. bone cement or paste] using wire, staple**
1UF82LA	**Reattachment, other metacarpal bones using simple apposition technique [e.g. suturing]**
1UF87LANW	**Excision partial, other metacarpal bones no tissue used (for closure of defect) using plate, screw**
1UG80LAXXA	**Repair, other metacarpophalangeal joint(s) joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] no device used (for repair)**
1UG80VJ	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal osteotomy no tissue used (for repair) no device used (for repair)**

1UH73JA	**Reduction, first metacarpophalangeal joint using closed (external) approach**
1UJ80LAKDG	**Repair, other phalanx of hand using pedicled transposition flap [finger rotation flap, pollicization] using wire, staple**
1UK52WJ	**Drainage, other interphalangeal joints of hand using open excisional approach [e.g. bursectomy]**
1UK80LAKDN	**Repair, other interphalangeal joints of hand joint repair alone with synthetic tissue [e.g. silastic sheath] using wire, staple, tension band**
1US80WUXXE	**Repair, extensor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with tendon transfer for realignment [e.g. advancement, transposition]**
1BN87UH	**Excision partial, nerve(s) of forearm and wrist interfascicular split repair [rejoining] technique simple apposition of nerve ends**
1BN87UHXXA	**Excision partial, nerve(s) of forearm and wrist interfascicular split repair [rejoining] technique nerve autograft (to replace lost length)**
1BN87UHXXE	**Excision partial, nerve(s) of forearm and wrist interfascicular split repair [rejoining] technique transposition of nerves [e.g. crossover]**
1BP87WG	**Excision partial, nerve(s) of hand no rejoining [of nerve ends] nerve end fascicles coagulated (and buried)**
1BQ87LAXXE	**Excision partial, nerve(s) of digit of hand end-to-end [rejoining] technique (e.g. suture, glue) transposition of nerves [e.g. crossover]**
1JJ80LA	**Repair, brachiocephalic arteries using open approach without tissue [e.g. direct repair or end-to-end anastomosis]**
1TQ87LAXXE	**Excision partial, muscles of the forearm [around elbow] using local transposition flap [e.g. advancement muscle or Z-plasty skin flap] (for closure of defect)**
1TS80LAXXN	**Repair, tendons of the forearm [around elbow] using apposition technique [e.g. tendon sutured to tendon] with synthetic tissue [e.g. gortex, mesh]**
1TV52HA	**Drainage, radius and ulna using percutaneous (needle) approach**
1TV74LAKDK	**Fixation, radius and ulna open approach with bone homograft using wire, mesh, staple**
1TV87LAKD	**Excision partial, radius and ulna no tissue used (for closure of defect) using wire, mesh, staple**
1TV91LAPM	**Excision radical, radius and ulna no tissue used (for closure of defect) using**

	endoprosthesis [radial or humeral head]
1TX35HAP1	**Pharmacotherapy (local), soft tissue of arm NEC using percutaneous approach and local anesthetic agent**
1TX87LAXXF	**Excision partial, soft tissue of arm NEC using open approach and free flap [e.g. myocutaneous free flap] (to close surgical defect)**
1UB74LAKDQ	**Fixation, wrist joint open approach with combined sources of tissue [e.g. bone graft, cement/paste] using wire, mesh, staple**
1UB75LANW	**Fusion, wrist joint no tissue used (for fusion) using plate, screw**
1UC75LANV	**Fusion, distal radioulnar joint and carpal joints and bones fixation device [alone] using pin, nail**
1UC82LANW	**Reattachment, distal radioulnar joint and carpal joints and bones using open approach and plate/screw fixation with apposition**
1UC87GB	**Excision partial, distal radioulnar joint and carpal joints and bones endoscopic [arthroscopic] approach, synovectomy or ganglionectomy alone**
1UF74HALQ	**Fixation, other metacarpal bones percutaneous approach [e.g. with closed or no reduction] fixation device alone using intramedullary nail**
1UF74LANWN	**Fixation, other metacarpal bones open approach with synthetic tissue [e.g. bone cement or paste] using plate, screw**
1UF84LAXXE	**Construction or reconstruction, other metacarpal bones using open approach and local flap [for closure]**
1UG55LANV	**Removal of device, other metacarpophalangeal joint(s) of pin/nail using open approach**
1UG75LANW	**Fusion, other metacarpophalangeal joint(s) joint fusion alone no tissue used (for fusion) using screw, plate and screw**
1UH80LANV	**Repair, first metacarpophalangeal joint, joint repair alone no tissue used (for repair) using pin, nail**
1UI03HAKC	**Immobilization, first phalanx of hand using percutaneous external fixator**
1UV80WUXXE	**Repair, tendons of wrist and hand using tenodesis technique [tendon looped or sutured to or through bone] with tendon transfer for realignment [e.g. advancement, transposition]**
1UY87LAXXQ	**Excision partial, soft tissue of the wrist and hand using open approach and combined sources of tissue [e.g. skin graft with flap] (for closure of defect)**

1TQ80LAXXF	**Repair, muscles of the forearm [around elbow] using open approach and free flap**
1TS80WUNWE	**Repair, tendons of the forearm [around elbow] using tenodesis with screw fixation [e.g. tendon with a bone plug fixed to bone with screw] with tendon transfer for realignment, [e.g. advancement, transposition]**
1TV80LAKDA	**Repair, radius and ulna with autograft [e.g. bone, tendon] using wire, mesh, staple**
1TV80LAKDN	**Repair, radius and ulna with synthetic tissue [e.g. bone cement, paste] using wire, mesh, staple**
1TZ70LA	**Incision NOS, arm NEC using open approach**
1UB74HALQ	**Fixation, wrist joint percutaneous approach (e.g. with closed or no reduction) fixation device alone using intramedullary nail**
1UB74LAKDK	**Fixation, wrist joint open approach with bone homograft using wire, mesh, staple**
1UC57LA	**Extraction, distal radioulnar joint and carpal joints and bones using open approach**
1UC79LANW	**Repair by increasing size, distal radioulnar joint and carpal joints and bones no tissue used in lengthening [or distracting] using plate, screw**
1UC82LAKD	**Reattachment, distal radioulnar joint and carpal joints and bones using open approach and wire/staple fixation with apposition**
1UE55HAKD	**Removal of device, first metacarpal bone of wire/staple/tension band using percutaneous approach**
1UF80LAKDA	**Repair, other metacarpal bones with bone autograft using wire, staple**
1UF80LANWA	**Repair, other metacarpal bones with bone autograft using plate, screw**
1UF87LAKD	**Excision partial, other metacarpal bones no tissue used (for closure of defect) using wire, staple**
1UF87LAXXN	**Excision partial, other metacarpal bones with synthetic tissue [e.g. bone cement, or paste], no device used**
1UG57LA	**Extraction, metacarpophalangeal joint(s) using open approach**
1UG80LAKDA	**Repair, other metacarpophalangeal joint(s) joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using wire, staple, tension band**
1UG80VJKD	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal**

	osteotomy no tissue used (for repair) using wire, staple, tension band
1UI55HAKD	**Removal of device, first phalanx of hand of wire/staple using percutaneous approach**
1UI87LAXXA	**Excision partial, first phalanx of hand using open approach and autograft**
1UJ74LANVA	**Fixation, other phalanx of hand open approach with bone autograft using pin, nail**
1UK75HAKD	**Fusion, other interphalangeal joints of hand percutaneous approach using wire, tension band**
1UK80VJNW	**Repair, other interphalangeal joints of hand joint repair with phalangeal osteotomy (for realigning joint) no tissue used (for repair) using screw, plate and screw**
1UM80LANW	**Repair, first interphalangeal joint of hand, joint repair alone no tissue used (for repair) using screw, plate and screw**
1UT55LASL	**Removal of device, flexor tendons of finger [ecludes thumb] of spacer device [e.g. Silastic rod] using open approach**
1YT87LAXXA	**Excision partial, skin of arm open [excisional] approach using full thickness autograft**
1TM93LA	**Amputation, elbow joint using simple apposition technique [e.g. suturing] (for closure of stump)**
1TS80WUNWN	**Repair, tendons of the forearm [around elbow] using tenodesis with screw fixation [e.g. tendon with a bone plug fixed to bone with screw] with synthetic tissue [e.g. gortex, mesh]**
1TS80WUXXN	**Repair, tendons of the forearm [around elbow] using tenodesis technique [e.g. tendon looped or sutured to or through bone] with synthetic tissue [e.g. gortex, mesh]**
1TV82LANWA	**Reattachment, radius and ulna using open approach and plate/screw fixation with bone autograft**
1TV87LANWN	**Excision partial, radius and ulna with synthetic tissue [e.g. bone cement or paste] using screw, plate and screw**
1TV93LAXXA	**Amputation, radius and ulna using skin graft (for closure of stump)**
1UB53LAPMN	**Implantation of internal device, wrist joint with synthetic material (e.g. bone paste, cement, Dynagraft, Osteoset) using single-component prosthetic device [e.g. styloid process of radius]**

1UB57LA	**Extraction, wrist joint using open approach**
1UB74LALQ	**Fixation, wrist joint open approach fixation device alone using intramedullary nail**
1UB80LAXXN	**Repair, wrist joint open approach using synthetic tissue [e.g. mesh, gortex, silastic sheath]**
1UB93LAXXE	**Amputation, wrist joint using local flap myoplasty or myodesis (for closure of stump)**
1UC53LAPM	**Implantation of internal device, distal radioulnar joint and carpal joints and bones of single-component prosthetic device using open approach**
1UC53LAQD	**Implantation of internal device, distal radioulnar joint and carpal joints and bones of single component prosthetic device with (additional) wire fixation using open approach**
1UC74LAKDQ	**Fixation, distal radioulnar joint and carpal joints and bones open approach with combined sources of tissue [e.g. bone graft, cement/paste] using wire, staple**
1UC74LANVN	**Fixation, distal radioulnar joint and carpal joints and bones open approach with synthetic tissue [bone cement, paste] using pin, nail**
1UC80LAXXQ	**Repair, distal radioulnar joint and carpal joints and bones open approach using combined sources of tissue [autograft with synthetic tissue]**
1UE87LA	**Excision partial, first metacarpal bone no tissue used (for repair) no device used**
1UF74LANVA	**Fixation, other metacarpal bones open approach with bone autograft using pin, nail**
1UF80LANV	**Repair, other metacarpal bones no tissue used (for repair) using pin, nail**
1UG55LANW	**Removal of device, other metacarpophalangeal joint(s) of screw/plate using open approach**
1UH72LA	**Release, first metacarpophalangeal joint using open (incisional) approach**
1UH75LANW	**Fusion, first metacarpophalangeal joint, joint fusion alone no tissue used (for fusion) using screw, plate and screw**
1UH87LA	**Excision partial, first metacarpophalangeal joint using other excisional technique [e.g. arthrectomy, chondrectomy] (with or without synovectomy)**
1UH93LA	**Amputation, first metacarpophalangeal joint using simple apposition technique [e.g. suturing] (for closure of stump)**

1UI74LANWA	**Fixation, first phalanx of hand open approach with bone autograft using plate, screw**
1UI80LAXXA	**Repair, first phalanx of hand using autograft [e.g. bone peg] no device used**
1UI80LAXXG	**Repair, first phalanx of hand using pedicled transposition flap [finger rotation flap, pollicization] no device used**
1UI93LAXXF	**Amputation, first phalanx of hand using free flap [e.g. toe-to-finger flap]**
1UJ74LANVN	**Fixation, other phalanx of hand open approach with synthetic tissue [bone cement, paste] using pin, nail**
1UK52WKTS	**Drainage, other interphalangeal joints of hand using open incisional approach [e.g. bursotomy] and leaving drainage tube [catheter] in situ**
1UK80VJKDA	**Repair, other interphalangeal joints of hand joint repair with phalangeal osteotomy (for realigning joint) with autograft [e.g. bone, interpositional tendon, fascia] using wire, staple, tension band**
1UM72LA	**Release, first interphalangeal joint of hand using open (incisional) approach**
1UM75LANW	**Fusion, first interphalangeal joint of hand open approach using screw**
1US80WUXXN	**Repair, extensor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with synthetic tissue [e.g. gortex, mesh]**
1UU80WUXXN	**Repair, tendons of thumb [Pollicis tendons] using tenodesis technique [tendon looped or sutured to or through bone] with synthetic tissue [e.g. gortex, mesh]**
1BN80LAW3	**Repair, nerve(s) of forearm and wrist using fibrin glue [rejoining] technique**
1BN87LAXXN	**Excision partial, nerve(s) of forearm and wrist, no rejoining [of nerve ends] nerve end(s) wrapped or bridged using synthetic tissue [e.g. neural tube]**
1BP87LAXXN	**Excision partial, nerve(s) of hand, no rejoining (of nerve ends), nerve end(s) wrapped or bridged using synthetic tissue [e.g. neural tube]**
1BQ87UH	**Excision partial, nerve(s) of digit of hand interfascicular split repair [rejoining] technique simple apposition of nerve ends**
1BQ87WG	**Excision partial, nerve(s) of digit of hand no rejoining[of nerve ends] nerve end fascicles coagulated (and buried)**
1JM50GQBD	**Dilation, arteries of arm NEC using percutaneous transluminal approach and balloon dilator**

1JM51LAW3	**Occlusion, arteries of arm NEC using open approach and fibrin glue**
1TK93LAXXA	**Amputation, humerus using skin graft (for closure of stump)**
1TS80WUNWA	**Repair, tendons of the forearm [around elbow] using tenodesis with screw fixation [e.g. tendon with a bone plug fixed to bone with screw] with autograft [e.g. tendon, fascia]**
1TV58LAXXG	**Procurement, radius and ulna of pedicled flap using open approach**
1TV80LAKDK	**Repair, radius and ulna with bone homograft using wire, mesh, staple**
1TV87LAPMN	**Excision partial, radius and ulna with synthetic tissue [e.g. bone cement or paste] using endoprosthesis [radial or humeral head]**
1TX35HAL7	**Pharmacotherapy (local), soft tissue of arm NEC using percutaneous approach and bacterial toxin (e.g. botulinum toxin or Botox)**
1UB04JH	**Mobilization, wrist joint using external approach with manual technique**
1UB35HAP2	**Pharmacotherapy (local), wrist joint using percutaneous (needle) approach and analgesic agent**
1UB75LANV	**Fusion, wrist joint no tissue used (for fusion) using pin, nail**
1UB75LANVA	**Fusion, wrist joint with bone autograft using pin, nail**
1UC80LAXXG	**Repair, distal radioulnar joint and carpal joints and bones open approach using pedicled flap [e.g. radial bone with vascular pedicle]**
1UE56LA	**Removal of foreign body, first metacarpal bone using open approach**
1UE74LANWA	**Fixation, first metacarpal bones open approach with bone autograft using plate, screw**
1UE80LAKD	**Repair first metacarpal bone, no tissue used (for repair) using wire, staple**
1UE93LAXXE	**Amputation, first metacarpal bone using local flap [e.g. myoplasty or myodesis] (for closure of stump)**
1UF74LAKDK	**Fixation, other metacarpal bones open approach with bone homograft using wire, staple**
1UF80LAXXA	**Repair, other metacarpal bones with bone autograft no device used**
1UF84LAXXQ	**Construction or reconstruction, other metacarpal bones using open approach and local flap with skin autograft [for closure]**
1UG52HA	**Drainage, other metacarpophalangeal joint(s) using percutaneous (needle) aspiration**

1UG52WJ	**Drainage, other metacarpophalangeal joint(s) using open excisional approach [e.g. bursectomy]**
1UG72JA	**Release, metacarpophalangeal joint(s) using manual technique**
1UG75VJNW	**Fusion, other metacarpophalangeal joint(s) joint fusion with metacarpal osteotomy no tissue used (for fusion) using screw, plate and screw**
1UG80VJNW	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal osteotomy no tissue used (for repair) using screw, plate and screw**
1UH75LAKD	**Fusion, first metacarpophalangeal joint, joint fusion alone no tissue used (for fusion) using wire, staple, tension band**
1UH80LAXXN	**Repair, first metacarpophalangeal joint, joint repair alone with synthetic tissue [e.g. silastic sheath] no device used (for repair)**
1UH80VJ	**Repair, first metacarpophalangeal joint, joint repair with metacarpal osteotomy no tissue used (for repair) no device used (for repair)**
1UI74LAKDN	**Fixation, first phalanx of hand open approach with synthetic tissue [bone, cement, paste] using wire, staple, tension band**
1UI74LALQ	**Fixation, first phalanx of hand open approach fixation device alone using intramedullary nail**
1UI74LANWN	**Fixation, first phalanx of hand open approach with synthetic tissue [bone, cement, paste] using plate, screw**
1UI87LAXXQ	**Excision partial, first phalanx of hand using open approach and combined sources of tissue**
1UI93LAXXB	**Amputation, first phalanx of hand using split-thickness skin graft (for closure of stump)**
1UK55LAPM	**Removal of device, other interphalangeal joints of hand of uncemented single-component prosthetic device using open approach**
1UK80LAKDQ	**Repair, other interphalangeal joints of hand joint repair alone with combined sources of tissue [e.g. bone graft, synthetic tissue] using wire, staple, tension band**
1UM80LAKDA	**Repair, first interphalangeal joint of hand, joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using wire, staple, tension band**
1US53LASL	**Implantation of internal device, extensor tendons of finger [excludes thumb] using open approach and spacer device [e.g. Silastic rod]**

1US80WUNWE	**Repair, extensor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with tendon transfer for realignment [e.g. advancement, transposition]**
1US80WUNWQ	**Repair, extensor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1US80WUXXQ	**Repair, extensor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UT80WUNWE	**Repair, flexor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with tendon transfer for realignment [e.g. advancement, transposition]**
1UT80WUXXQ	**Repair, flexor tendons of finger [excludes thumb] using tenodesis technique [tendon looped or sutured to or through bone] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UU80WUNWE	**Repair, tendons of thumb [Pollicis tendons] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with tendon transfer for realignment [e.g. advancement, transposition]**
1UV80WUNWE	**Repair, tendons of wrist and hand using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with tendon transfer for realignment [e.g. advancement, transposition]**
1UV80WUXXQ	**Repair, tendons of wrist and hand using tenodesis technique [tendon looped or sutured to or through bone] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1YT80LAXXG	**Repair, skin of arm using pedicled (distant)flap**
1YX80LAW4	**Repair, nail using open approach and glue (e.g. crazy glue, glustitch)**
1YX80LAXXB	**Repair, nail using open approach and split-thickness autograft**
1YX89LAXXA	**Excision total, nail using open [excisional] approach and full-thickness autograft**
2BG70LL	**Inspection, brachial plexus using anterior open approach**
1TM93LAXXE	**Amputation, elbow joint using local flap myoplasty or myodesis (for closure of stump)**
1TS58LAXXF	**Procurement, tendons of the forearm [around elbow] of free flap (innervated with artery pedicle)**

1TV52HAJ2	**Drainage, radius and ulna using percutaneous (needle) approach and steroid infiltration**
1TV55LAPM	**Removal of device, radius and ulna of endoprosthesis using open approach**
1TV80LANVN	**Repair, radius and ulna with synthetic tissue [e.g. bone cement, paste] using pin, nail**
1TV83LAXXQ	**Transfer, radius and ulna using open approach and combined sources of tissue [e.g. bone graft and cement/paste]**
1TV87LAPMK	**Excision partial, radius and ulna with bone homograft [e.g. from bone bank] using endoprosthesis [radial or humeral head]**
1TV91LAPMN	**Excision radical, radius and ulna with synthetic tissue [e.g. bone cement or paste] using endoprosthesis [radial or humeral head]**
1UB53LAPNA	**Implantation of internal device, wrist joint with bone autograft [uncemented] dual-component prosthetic device [e.g. proximal radius and ulnar head with or without scaphoid or lunate component]**
1UB55LAPM	**Removal of device, wrist joint of uncemented single component prosthetic device using open approach**
1UB74LANVQ	**Fixation, wrist joint open approach with combined sources of tissue [e.g. bone graft, cement/paste] using pin, nail**
1UB75LANWQ	**Fusion, wrist joint with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1UB80DAXXA	**Repair, wrist joint endoscopic [arthroscopic] approach using autograft [e.g. bone, interpositional fascia lata, muscle graft, rolled ôanchovyö graft]**
1UB80LAXXQ	**Repair, wrist joint open approach using combined sources of tissue [autograft with synthetic tissue]**
1UC55LAPM	**Removal of device, distal radioulnar joint and carpal joints and bones of single- component prosthetic device**
1UC80DAXXA	**Repair, distal radioulnar joint and carpal joints and bones endoscopic [arthroscopic] approach using autograft [e.g. bone, interpositional fascia lata, tendon graft, rolled 'anchovy' graft]**
1UC82LA	**Reattachment, distal radioulnar joint and carpal joints and bones using open approach and apposition [suturing]**
1UC82LAXXF	**Reattachment, distal radioulnar joint and carpal joints and bones using open approach and free flap [e.g. myocutaneous, osseocutaneous flap]**

1UE74LAKDA	**Fixation, first metacarpal bones open approach with bone autograft using wire, staple**
1UE80LANV	**Repair first metacarpal bone, no tissue used (for repair) using pin, nail**
1UE80LANW	**Repair first metacarpal bone, no tissue used (for repair) using plate, screw**
1UE82LA	**Reattachment, first metacarpal bone using simple apposition technique [e.g. suturing]**
1UE82LANW	**Reattachment, first metacarpal bone using plate/screw fixation with apposition technique**
1UE82LAXXF	**Reattachment, first metacarpal bone using free flap [e.g. myocutaneous, osseocutaneous flap]**
1UE93LA	**Amputation, first metacarpal bone using simple apposition technique [e.g. suturing] (for closure of stump)**
1UF74LAKDQ	**Fixation, other metacarpal bones open approach with combined bone graft and cement, paste using wire, staple**
1UF74LANVN	**Fixation, other metacarpal bones open approach with synthetic tissue [e.g. bone cement or paste] using pin, nail**
1UF74LANWK	**Fixation, other metacarpal bones open approach with bone homograft using plate, screw**
1UF74LANWQ	**Fixation, other metacarpal bones open approach with combined sources of tissue [e.g. graft & cement/paste] using plate, screw**
1UF79HAMG	**Repair by increasing size, other metacarpal bones using distraction device [e.g. Ilizarov circular frame]**
1UF80LAXXN	**Repair, other metacarpal bones with synthetic tissue [e.g. bone cement, or paste] no device used**
1UF87LANWK	**Excision partial, other metacarpal bones with bone homograft (to close defect) using plate, screw**
1UF87LAXXK	**Excision partial, other metacarpal bones with bone homograft (to close defect), no device used**
1UF87LAXXQ	**Excision partial, other metacarpal bones with combined sources of tissue [e.g. bone graft, cement/paste], no device used**
1UG74HANW	**Fixation, other metacarpophalangeal joint(s) percutaneous approach [e.g. with closed or no reduction] fixation device alone using plate, screw**

1UG80LAKDN	**Repair, other metacarpophalangeal joint(s) joint repair alone with synthetic tissue [e.g. silastic sheath] using wire, staple, tension band**
1UH53LAPN	**Implantation of internal device, first metacarpophalangeal joint of uncemented dual-component prosthetic device using open approach**
1UH55LANV	**Removal of device, first metacarpophalangeal joint of pin, nail using open approach**
1UH74LALQ	**Fixation, first metacarpophalangeal joint, open approach, fixation device alone using intramedullary nail**
1UH75VJKD	**Fusion, first metacarpophalangeal joint, joint fusion with metacarpal osteotomy no tissue used (for fusion) using wire, staple, tension band**
1UH75VJNWA	**Fusion, first metacarpophalangeal joint, joint fusion with metacarpal osteotomy with bone autograft using screw, plate and screw**
1UH80LAKDA	**Repair, first metacarpophalangeal joint, joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using wire, staple, tension band**
1UH93LAXXE	**Amputation, first metacarpophalangeal joint using local flap myoplasty or myodesis (for closure of stump)**
1UI74HALQ	**Fixation, first phalanx of hand percutaneous approach [e.g. with closed or no reduction] fixation device alone using intramedullary nail**
1UI80LANWA	**Repair, first phalanx of hand using autograft** **[e.g. bone peg] using plate, screw**
1UI80LAXXF	**Repair, first phalanx of hand using free flap [e.g. toe to finger flap] no device used**
1UJ74LAKDQ	**Fixation, other phalanx of hand open approach with combined sources of tissue [e.g. bone graft, cement/paste] using wire, staple, tension band**
1UJ75LAKDE	**Fusion, other phalanx of hand using wire with local transposition flap (to join fingers together)**
1UJ75LAKDQ	**Fusion, other phalanx hand using wire with combined sources of tissue [e.g. local transposition flap and skin autograft**
1UJ87UR	**Excision partial, other phalanx of hand using ligature dissection technique**
1UK52HA	**Drainage, other interphalangeal joints of hand using percutaneous (needle) aspiration**
1UK80LAKDK	**Repair, other interphalangeal joints of hand joint repair alone with bone**

	homograft using wire, staple, tension band
1UK80LANVA	**Repair, other interphalangeal joints of hand joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using pin, nail**
1UK80LANWK	**Repair, other interphalangeal joints of hand joint repair alone with bone homograft using screw, plate and screw**
1UK80VJNWA	**Repair, other interphalangeal joints of hand joint repair with phalangeal osteotomy (for realigning joint) with autograft [e.g. bone, interpositional tendon, fascia] using screw, plate and screw**
1UM52WJ	**Drainage, first interphalangeal joint of hand using open excisional approach [e.g. bursectomy]**
1UM52WK	**Drainage, first interphalangeal joint of hand using open incisional approach [e.g. bursotomy]**
1UM74HANW	**Fixation, first interphalangeal joint of hand using percutaneous (closed) approach and plate/screw**
1UM80LANVA	**Repair, first interphalangeal joint of hand, joint repair alone with autograft [e.g. bone interpositional tendon, fascia] using pin, nail**
1UM80LAXXA	**Repair, first interphalangeal joint of hand, joint repair alone with autograft [e.g. bone interpositional tendon, fascia] no device used (for repair)**
1UM80VJKD	**Repair, first interphalangeal joint of hand, joint repair with phalangeal osteotomy (for realigning joint) no tissue used (for repair) using wire, staple, tension band**
1UM80VJKDA	**Repair, first interphalangeal joint of hand, joint repair with phalangeal osteotomy (for realigning joint) with autograft [e.g. bone, interpositional tendon, fascia] using wire, staple, tension band**
1UM80VJNWA	**Repair, first interphalangeal joint of hand, joint repair with phalangeal osteotomy (for realigning joint) with autograft [e.g. bone, interpositional tendon, fascia] using screw, plate and screw**
1US80WUNWA	**Repair, extensor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with autograft [e.g. tendon, fascia]**
1US80WUNWN	**Repair, extensor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with synthetic tissue [e.g. gortex, mesh]**
1UT80WUNWN	**Repair, flexor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with synthetic**

	tissue [e.g. gortex, mesh]
1UV80LAXXN	**Repair, tendons of wrist and hand using apposition technique [e.g. tendon sutured to tendon] with synthetic tissue [e.g. gortex, mesh]**
1UV80LAXXQ	**Repair, tendons of wrist and hand using apposition technique [e.g. tendon sutured to tendon] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UY80LAXXN	**Repair, soft tissue of the wrist and hand using open approach and synthetic tissue [e.g. gortex, mesh or Silastic sheath]**
1BF80LA	**Repair, sympathetic nerves using end to end [whole] nerve suture technique**
1BM80LAW3	**Repair, nerve(s) of upper arm and elbow using fibrin glue [rejoining] technique**
1BM87UH	**Excision partial, nerve(s) of upper arm and elbow interfascicular split repair [rejoining] technique simple apposition of nerve ends**
1BP87LAXXE	**Excision partial, nerve(s) of hand end to end suture [rejoining] technique transposition of nerves [e.g. crossover]**
1BP87UHXXE	**Excision partial, nerve(s) of hand interfascicular split repair [rejoining] technique transposition of nerves [e.g. crossover]**
1BQ87UHXXQ	**Excision partial, nerve(s) of digit of hand interfascicular split repair [rejoining] technique combined transposition of nerves with a nerve autograft**
1JJ50LANR	**Dilation, brachiocephalic arteries open approach using endovascular stent [e.g. Z-stent]**
1JJ51LA	**Occlusion, brachiocephalic arteries using open approach without tissue [direct repair]**
1JJ80LAXXN	**Repair, brachiocephalic arteries using open approach with synthetic material**
1JJ87LA	**Excision partial, brachiocephalic arteries using open approach without tissue [e.g. direct repair or end-to-end anastomosis]**
1SN93LAXXE	**Amputation, scapula using local flap myoplasty (for closure of stump)**
1TQ80LAXXN	**Repair, muscles of the forearm [around elbow] using open approach and synthetic tissue [e.g. gortex, mesh or Silastic sheath]**
1TQ87LAXXA	**Excision partial, muscles of the forearm [around elbow] using autograft [e.g.**

	fascia or skin] (for closure of surgical defect)
1TS80WUNWQ	**Repair, tendons of the forearm [around elbow] using tenodesis with screw fixation [e.g. tendon with a bone plug fixed to bone with screw] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1TV56JA	**Removal of foreign body, radius and ulna using external (manual extraction) approach**
1TV74LALQA	**Fixation, radius and ulna open approach with bone autograft using intramedullary nail**
1TV74LALQN	**Fixation, radius and ulna open approach with synthetic tissue [e.g. bone cement or paste] using intramedullary nail**
1TV80LANVK	**Repair, radius and ulna with bone homograft using pin, nail**
1TV80LANVQ	**Repair, radius and ulna with combined sources of tissue [e.g. bone graft, cement/paste] using pin, nail**
1TV83LAXXK	**Transfer, radius and ulna using open approach and bone homograft**
1TV84LAXXE	**Construction or reconstruction, radius and ulna using open approach and local rotation flap (muscle and skin to cover each ray)**
1TV87LANV	**Excision partial, radius and ulna no tissue used (for closure of defect) using pin, nail**
1TV87LANVK	**Excision partial, radius and ulna with bone homograft [e.g. from bone bank] using pin, nail**
1TV87LANWK	**Excision partial, radius and ulna with bone homograft [e.g. from bone bank] using screw, plate and screw**
1TV91LANWA	**Excision radical, radius and ulna with bone autograft using screw, plate and screw**
1TX87LAXXQ	**Excision partial, soft tissue of arm NEC using open approach and combined sources of tissue [e.g. skin graft with flap] (to close surgical defect)**
1UB72DA	**Release, wrist joint using endoscopic [arthroscopic] approach**
1UB74DANWN	**Fixation, wrist joint endoscopic [arthroscopic] approach with synthetic tissue [e.g. bone cement, or paste] using plate, screw**
1UB74DANWQ	**Fixation, wrist joint endoscopic [arthroscopic] approach with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1UB74LALQK	**Fixation, wrist joint open approach with bone homograft using**

	intramedullary nail
1UB74LALQN	**Fixation, wrist joint open approach with synthetic tissue [e.g. bone cement, or paste] using intramedullary nail**
1UB75LALQA	**Fusion, wrist joint with bone autograft using intramedullary nail**
1UB75LANWN	**Fusion, wrist joint with synthetic tissue [e.g. bone cement, paste] using plate, screw**
1UB75LAXXA	**Fusion, wrist joint with bone autograft with no device used (for fusion)**
1UB80DAXXE	**Repair, wrist joint endoscopic [arthroscopic] approach using local tendon transfer [rebalancing]**
1UB93LAXXA	**Amputation, wrist joint using skin graft (for closure of stump]**
1UC55LASL	**Removal of device, distal radioulnar joint and carpal joints and bones of spacer device [e.g. Silastic] using open approach**
1UC74LANVQ	**Fixation, distal radioulnar joint and carpal joints and bones open approach with combined sources of tissue [e.g. bone graft, cement/paste] using pin, nail**
1UC80LANWK	**Repair, distal radioulnar joint and carpal joints and bones open approach with screw/plate device using homograft**
1UC80LANWQ	**Repair, distal radioulnar joint and carpal joints and bones open approach with screw/plate using combined sources of tissue [e.g. autograft with synthetic tissue]**
1UC80LAXXK	**Repair, distal radioulnar joint and carpal joints and bones open approach using homograft**
1UE55LANV	**Removal of device, first metacarpal bone of pin/nail using open approach**
1UE55LANW	**Removal of device, first metacarpal bone of plate/screw using open approach**
1UE74LAKDN	**Fixation, first metacarpal bones open approach with synthetic tissue [e.g. bone cement or paste] using wire, staple**
1UE74LALQ	**Fixation, first metacarpal bones open approach fixation device alone using intramedullary nail**
1UE74LANVA	**Fixation, first metacarpal bones open approach with bone autograft using pin, nail**
1UE74LANWK	**Fixation, first metacarpal bones open approach with bone homograft using**

	plate, screw
1UE74LANWQ	**Fixation, first metacarpal bones open approach with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1UE80LAXXA	**Repair first metacarpal bone, with bone autograft no device used**
1UE80LAXXN	**Repair first metacarpal bone, with synthetic tissue [e.g. bone cement, or paste] no device used**
1UE82LANWN	**Reattachment, first metacarpal bone using plate/screw fixation with synthetic tissue [e.g. bone cement or paste]**
1UE87LAKD	**Excision partial, first metacarpal bone no tissue used (for repair) using wire, staple**
1UF56JA	**Removal of foreign body, other metacarpal bones using external (manual extraction) approach**
1UF74LALQQ	**Fixation, other metacarpal bones open approach with combined sources of tissue [e.g. graft & cement/paste] using intramedullary nail**
1UF80LAKDQ	**Repair, other metacarpal bones with combined sources of tissue [e.g. bone graft, cement/paste] using wire, staple**
1UF80LANVQ	**Repair, other metacarpal bones with combined sources of tissue [e.g. bone graft, cement/paste] using pin, nail**
1UF80LANWN	**Repair, other metacarpal bones with synthetic tissue [e.g. bone cement, or paste] using plate, screw**
1UF82LANWA	**Reattachment, other metacarpal bones using plate/screw fixation with bone autograft**
1UF82LANWN	**Reattachment, other metacarpal bones using plate/screw fixation with synthetic tissue [e.g. bone cement or paste]**
1UF87LAKDA	**Excision partial, other metacarpal bones with bone autograft (to close defect) using wire, staple**
1UF87LAKDQ	**Excision partial, other metacarpal bones with combined sources of tissue [e.g. bone graft, cement/paste] using wire, staple**
1UF87LANV	**Excision partial, other metacarpal bones no tissue used (for closure of defect) using pin, nail**
1UG74HALQ	**Fixation, other metacarpophalangeal joint(s) percutaneous approach [closed], fixation device alone using intramedullary nail**

1UG74LANVA	**Fixation, other metacarpophalangeal joint(s) open approach with bone autograft using pin, nail**
1UG74LANWQ	**Fixation, other metacarpophalangeal joint(s) open approach with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1UG75LAKDA	**Fusion, other metacarpophalangeal joint(s) joint fusion alone with bone autograft using wire, staple, tension band**
1UG75LAKDK	**Fusion, other metacarpophalangeal joint(s) joint fusion alone with bone homograft using wire, staple, tension band**
1UG75LANWA	**Fusion, other metacarpophalangeal joint(s) joint fusion alone with bone autograft using screw, plate and screw**
1UG75LANWN	**Fusion, other metacarpophalangeal joint(s) joint fusion alone with synthetic tissue [e.g. bone cement, paste] using screw, plate and screw**
1UG75LAXXA	**Fusion, other metacarpophalangeal joint(s) joint fusion alone with bone autograft no device used (for fusion)**
1UG75VJNV	**Fusion, other metacarpophalangeal joint(s) joint fusion with metacarpal osteotomy no tissue used (for fusion) using pin, nail**
1UG75VJNWA	**Fusion, other metacarpophalangeal joint(s) joint fusion with metacarpal osteotomy with bone autograft using screw, plate and screw**
1UG75VJNWK	**Fusion, other metacarpophalangeal joint(s) joint fusion with metacarpal osteotomy with bone homograft using screw, plate and screw**
1UG80LANVA	**Repair, other metacarpophalangeal joint(s) joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using pin, nail**
1UG80LANVK	**Repair, other metacarpophalangeal joint(s) joint repair alone with bone homograft using pin, nail**
1UG80LANWQ	**Repair, other metacarpophalangeal joint(s) joint repair alone with combined sources of tissue [e.g. bone graft, synthetic tissue] using screw, plate and screw**
1UG80LAXXK	**Repair, other metacarpophalangeal joint(s) joint repair alone with bone homograft no device used (for repair)**
1UG80LAXXN	**Repair, other metacarpophalangeal joint(s) joint repair alone with synthetic tissue [e.g. silastic sheath] no device used (for repair)**
1UG80VJKDA	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal osteotomy with autograft [e.g. bone, interpositional tendon, fascia] using wire, staple, tension band**

1UG80VJKDN	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal osteotomy with synthetic tissue [e.g. silastic sheath] using wire, staple, tension band**
1UG80VJNV	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal osteotomy no tissue used (for repair) using pin, nail**
1UG80VJNVA	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal osteotomy with autograft [e.g. bone, interpositional tendon, fascia] using pin, nail**
1UG80VJNWA	**Repair, other metacarpophalangeal joint(s) joint repair with metacarpal osteotomy with autograft [e.g. bone, interpositional tendon, fascia] using screw, plate and screw**
1UH55LAKD	**Removal of device, first metacarpophalangeal joint of wire, staple using open approach**
1UH55LANW	**Removal of device, first metacarpophalangeal joint of screw, plate using open approach**
1UH74LAKDA	**Fixation, first metacarpophalangeal joint open approach with bone autograft using wire, staple, tension band**
1UH74LANVA	**Fixation, first metacarpophalangeal joint using open approach with bone autograft using pin, nail**
1UH75LANWA	**Fusion, first metacarpophalangeal joint, joint fusion alone with bone autograft using screw, plate and screw**
1UH80LANVA	**Repair, first metacarpophalangeal joint, joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using pin, nail**
1UH80LANWA	**Repair, first metacarpophalangeal joint, joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] using screw, plate and screw**
1UH80LAXXA	**Repair, first metacarpophalangeal joint, joint repair alone with autograft [e.g. bone, interpositional tendon, fascia] no device used (for repair)**
1UH80VJKD	**Repair, first metacarpophalangeal joint, joint repair with metacarpal osteotomy no tissue used (for repair) using wire, staple, tension band**
1UI55LANW	**Removal of device, first phalanx of hand of plate/screw using open approach**
1UI71LAXXQ	**Division, first phalanx of hand, division involving skin and soft tissue only [simple syndactyly] using combination of local flap and skin autograft**
1UI74LANVA	**Fixation, first phalanx of hand open approach with bone autograft using pin, nail**

1UI74LANVQ	**Fixation, first phalanx of hand open approach with combined sources of tissue [e.g. bone graft, cement/paste] using pin, nail**
1UI80LAKDA	**Repair, first phalanx of hand using autograft [e.g. bone peg] using wire, staple**
1UJ71WKXXE	**Division, other phalanx of hand division involving bone or joint (complex syndactyly) using local flap [e.g. volar, dorsal]**
1UJ74LANVQ	**Fixation, other phalanx of hand open approach with combined sources of tissue [e.g. bone graft, cement/paste] using pin, nail**
1UJ74LANWQ	**Fixation, other phalanx of hand open approach with combined sources of tissue [e.g. bone graft, cement/paste] using plate, screw**
1UJ80LAKDK	**Repair, other phalanx of hand using bone homograft using wire, staple**
1UK53LAPMN	**Implantation of internal device, other interphalangeal joints of hand of cemented single-component prosthetic device using open approach**
1UK75HANW	**Fusion, other interphalangeal joints of hand percutaneous approach using screw**
1UK80LANVN	**Repair, other interphalangeal joints of hand joint repair alone with synthetic tissue [e.g. silastic sheath] using pin, nail**
1UK80LAXXN	**Repair, other interphalangeal joints of hand joint repair alone with synthetic tissue [e.g. silastic sheath] no device used (for repair)**
1UK80VJNV	**Repair, other interphalangeal joints of hand joint repair with phalangeal osteotomy (for realigning joint) no tissue used (for repair) using pin, nail**
1UM55HAKD	**Removal of device, first interphalangeal joint of hand of wire/staple using percutaneous approach**
1UM55LAKD	**Removal of device, first interphalangeal joint of hand of wire/staple/tension band using open approach**
1UM80LAKDK	**Repair, first interphalangeal joint of hand, joint repair alone with bone homograft using wire, staple, tension band**
1UM80VJ	**Repair, first interphalangeal joint of hand, joint repair with phalangeal osteotomy (for realigning joint) no tissue used (for repair) no device used (for repair)**
1UM80VJNW	**Repair, first interphalangeal joint of hand, joint repair with phalangeal osteotomy (for realigning joint) no tissue used (for repair) using screw, plate and screw**

1UT80WUNWQ	**Repair, flexor tendons of finger [excludes thumb] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UU55LASL	**Removal of device, tendons of thumb [Pollicis tendons] of spacer device [e.g. Silastic rod] using open approach**
1UU80WUNWA	**Repair, tendons of thumb [Pollicis tendons] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with autograft [e.g. tendon, fascia]**
1UU80WUNWQ	**Repair, tendons of thumb [Pollicis tendons] using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UU80WUXXQ	**Repair, tendons of thumb [Pollicis tendons] using tenodesis technique [tendon looped or sutured to or through bone] with combined sources of tissue [e.g. autograft, tendon transfer, goretex]**
1UV80WUNWA	**Repair, tendons of wrist and hand using tenodesis with screw fixation [tendon with a bone plug fixed to bone with screw] with autograft [e.g. tendon, fascia]**
1UV80WUXXN	**Repair, tendons of wrist and hand using tenodesis technique [tendon looped or sutured to or through bone] with synthetic tissue [e.g. gortex, mesh]**
1YX87LAXXB	**Excision partial, nail using open [excisional] approach and split-thickness autograft**
1YX89LAXXB	**Excision total, nail using open [excisional] approach and split-thickness autograft**
2BG70PF	**Inspection, brachial plexus using posterior open approach**

Appendix 2.4: Classification of ICD-10 diagnostic code into injury type.

	ICD-10 Code	**Diagnostic Code Description**
Injury Type		
amputation	**S489**	**Traumatic amputation of shoulder and upper arm, level unspecified**
amputation	**S580**	**Traumatic amputation at elbow level**
amputation	**S681**	**Traumatic amputation of other single finger (complete)(partial)**
amputation	**S682**	**Traumatic amputation of two or more fingers alone (complete)(partial)**
amputation	**S683**	**Combined traumatic amputation of (part of) finger(s) with other parts of wrist and hand**
amputation	**S581**	**Traumatic amputation at level between elbow and wrist**
amputation	**S589**	**Traumatic amputation of forearm, level unspecified**
amputation	**S680**	**Traumatic amputation of thumb (complete)(partial)**
amputation	**S684**	**Traumatic amputation of hand at wrist level**
amputation	**S688**	**Traumatic amputation of other parts of wrist and hand**
amputation	**S689**	**Traumatic amputation of wrist and hand, level unspecified**
amputation	**S612**	**Avulsion, finger, hand, wrist**
amputation	**T116**	**Traumatic amputation of upper limb, level unspecified**

burn	**T230**	**Burn of unspecified degree of wrist and hand**
burn	**T231**	**Burn of first degree of wrist and hand**
burn	**T232**	**Burn of second degree of wrist and hand**
burn	**T233**	**Burn of third degree of wrist and hand**
burn	**T234**	**Corrosion of unspecified degree of wrist and hand**
burn	**T235**	**Corrosion of first degree of wrist and hand**
burn	**T236**	**Corrosion of second degree of wrist and hand**
burn	**T237**	**Corrosion of third degree of wrist and hand**
burn	**T220**	**Burn of unspecified degree of shoulder and upper limb, except wrist and hand**
burn	**T221**	**Burn of first degree of shoulder and upper limb, except wrist and hand**
burn	**T222**	**Burn of second degree of shoulder and upper limb, except wrist and hand**
burn	**T223**	**Burn of third degree of shoulder and upper limb, except wrist and hand**
burn	**T224**	**Corrosion of unspecified degree of shoulder and upper limb, except wrist and hand**
burn	**T225**	**Corrosion of first degree of shoulder and upper limb, except wrist and hand**
burn	**T226**	**Corrosion of second degree of shoulder and upper limb, except wrist and hand**
burn	**T227**	**Corrosion of third degree of shoulder and upper limb, except wrist and hand**
crush/mangling	**S473**	**Crushing injury of upper arm**
crush/mangling	**S477**	**Crushing injury of multiple sites of shoulder & upper arm**
crush/mangling	**S478**	**Crushing injury of other specified parts of shoulder & upper arm**
crush/mangling	**S570**	**Crushing injury of elbow**

crush/mangling	**S670**	**Crushing injury of thumb and other finger(s)**
crush/mangling	**S578**	**Crushing injury of other parts of forearm**
crush/mangling	**S579**	**Crushing injury of forearm, part unspecified**
crush/mangling	**S678**	**Crushing injury of other and unspecified parts of wrist and hand**
crush/mangling	**S470**	**Crushing injury of shoulder region**
crush/mangling	**S471**	**Crushing injury of scapular region**
dislocation	**S53100**	**Anterior dislocation of elbow, closed**
dislocation	**S53110**	**Posterior dislocation of elbow, closed**
dislocation	**S53111**	**Posterior dislocation of elbow, open**
dislocation	**S53120**	**Medial dislocation of elbow, closed**
dislocation	**S53130**	**Lateral dislocation of elbow, closed**
dislocation	**S53180**	**Other dislocation of elbow, closed**
dislocation	**S53181**	**Other dislocation of elbow, open**
dislocation	**S53190**	**Unspecified dislocation of elbow, closed**
dislocation	**S53191**	**Unspecified dislocation of elbow, open**
dislocation	**S63100**	**Dislocation of metacarpophalangeal (joint) of finger, closed**
dislocation	**S63101**	**Dislocation of metacarpophalangeal (joint) of finger, open**
dislocation	**S63110**	**Dislocation of interphalangeal (joint) of finger, closed**
dislocation	**S63111**	**Dislocation of interphalangeal (joint) of finger, open**
dislocation	**S63180**	**Other dislocation of finger, closed**
dislocation	**S63181**	**Other dislocation of finger, open**
dislocation	**S63190**	**Unspecified dislocation of finger, closed**
dislocation	**S63191**	**Unspecified dislocation of finger, open**
dislocation	**S63200**	**Multiple dislocations of fingers, closed**

dislocation	**S63201**	**Multiple dislocations of fingers, open**
dislocation	**S530**	**Dislocation of radial head**
dislocation	**S63000**	**Dislocation of radioulnar (joint) distal, closed**
dislocation	**S63010**	**Dislocation of radiocarpal (joint), closed**
dislocation	**S63020**	**Dislocation of midcarpal (joint), closed**
dislocation	**S63030**	**Dislocation of carpometacarpal (joint), closed**
dislocation	**S63040**	**Dislocation of metacarpal (bone) proximal end, closed**
dislocation	**S63041**	**Dislocation of metacarpal (bone) proximal end, open**
dislocation	**S63080**	**Other dislocation of wrist, closed**
dislocation	**S63090**	**Unspecified dislocation of wrist, closed**
dislocation	**S63091**	**Unspecified dislocation of wrist, open**
dislocation	**T112**	**Dislocation, sprain and strain of unspecified joint and ligament of upper limb, level unspecified**
fracture	**S52000**	**Fracture of olecranon process of ulna, closed**
fracture	**S52001**	**Fracture of olecranon process of ulna, open**
fracture	**S52010**	**Fracture of coronoid process of ulna, closed**
fracture	**S62500**	**Fracture of proximal phalanx, closed**
fracture	**S62501**	**Fracture of proximal phalanx, open**
fracture	**S62510**	**Fracture of distal phalanx, closed**
fracture	**S62511**	**Fracture of distal phalanx, open**
fracture	**S62570**	**Fracture of multiple sites of thumb, closed**
fracture	**S62571**	**Fracture of multiple sites of thumb, open**
fracture	**S62590**	**Fracture of unspecified part of phalanx, closed**
fracture	**S62591**	**Fracture of unspecified part of phalanx, open**
fracture	**S62600**	**Fracture of middle or proximal phalanx of finger, closed**

fracture	**S62601**	**Fracture of middle or proximal phalanx of finger, open**
fracture	**S62610**	**Fracture of distal phalanx of finger, closed**
fracture	**S62611**	**Fracture of distal phalanx of finger, open**
fracture	**S62670**	**Fracture of multiple sites of finger, closed**
fracture	**S62671**	**Fracture of multiple sites of finger, open**
fracture	**S62690**	**Fracture of unspecified part of phalanx of finger, closed**
fracture	**S62691**	**Fracture of unspecified part of phalanx of finger, open**
fracture	**S62700**	**Multiple fractures of fingers, closed**
fracture	**S62701**	**Multiple fractures of fingers, open**
fracture	**S52020**	**Monteggia's fracture, closed**
fracture	**S52021**	**Monteggia's fracture, open**
fracture	**S52080**	**Other/multiple fractures of upper end of ulna, closed**
fracture	**S52081**	**Other/multiple fractures of upper end of ulna, open**
fracture	**S52090**	**Unspecified fracture of upper end of ulna, closed**
fracture	**S52091**	**Unspecified fracture of upper end of ulna, open**
fracture	**S52100**	**Fracture of head of radius, closed**
fracture	**S52101**	**Fracture of head of radius, open**
fracture	**S52110**	**Fracture of neck of radius, closed**
fracture	**S52111**	**Fracture of neck of radius, open**
fracture	**S52120**	**Fracture of radius with ulna, upper end, closed**
fracture	**S52121**	**Fracture of radius with ulna, upper end, open**
fracture	**S52180**	**Other/multiple fracture of upper end of radius, closed**
fracture	**S52181**	**Other/multiple fracture of upper end of radius, open**
fracture	**S52190**	**Unspecified fracture of upper end of radius, closed**

fracture	**S52191**	**Unspecified fracture of upper end of radius, open**
fracture	**S52200**	**Fracture of shaft of ulna, closed**
fracture	**S52201**	**Fracture of shaft of ulna, open**
fracture	**S52300**	**Fracture of shaft of radius, closed**
fracture	**S52301**	**Fracture of shaft of radius, open**
fracture	**S52400**	**Fracture of shafts of both ulna and radius, closed**
fracture	**S52401**	**Fracture of shafts of both ulna and radius, open**
fracture	**S52700**	**Multiple fractures of forearm, closed**
fracture	**S52701**	**Multiple fractures of forearm, open**
fracture	**S52800**	**Fracture of other parts of forearm, closed**
fracture	**S52801**	**Fracture of other parts of forearm, open**
fracture	**S52900**	**Fracture of forearm, part unspecified, closed**
fracture	**S52901**	**Fracture of forearm, part unspecified, open**
fracture	**S52500**	**Colles' fracture, closed**
fracture	**S52501**	**Colles' fracture, open**
fracture	**S52580**	**Other fracture of lower end of radius, closed**
fracture	**S52581**	**Other fracture of lower end of radius, open**
fracture	**S52590**	**Unspecified fracture of lower end of radius, closed**
fracture	**S52591**	**Unspecified fracture of lower end of radius, open**
fracture	**S52600**	**Fracture of lower end of both ulna and radius, closed**
fracture	**S52601**	**Fracture of lower end of both ulna and radius, open**
fracture	**S62000**	**Fracture of navicular [scaphoid] bone of hand, closed**
fracture	**S62001**	**Fracture of navicular [scaphoid] bone of hand, open**
fracture	**S62100**	**Fracture of lunate bone, closed**

fracture	**S62101**	**Fracture of lunate bone, open**
fracture	**S62110**	**Fracture of triquetral bone, closed**
fracture	**S62111**	**Fracture of triquetral bone, open**
fracture	**S62120**	**Fracture of pisiform bone, closed**
fracture	**S62130**	**Fracture of trapezium bone, closed**
fracture	**S62131**	**Fracture of trapezium bone, open**
fracture	**S62140**	**Fracture of trapezoid bone, closed**
fracture	**S62150**	**Fracture of capitate bone, closed**
fracture	**S62160**	**Fracture of hamate bone, closed**
fracture	**S62180**	**Fracture of other carpal bones, closed**
fracture	**S62181**	**Fracture of other carpal bones, open**
fracture	**S62190**	**Fracture of unspecified carpal bones, closed**
fracture	**S62191**	**Fracture of unspecified carpal bones, open**
fracture	**S62200**	**Fracture of base of first metacarpal bone, closed**
fracture	**S62201**	**Fracture of base of first metacarpal bone, open**
fracture	**S62210**	**Fracture of shaft of first metacarpal bone, closed**
fracture	**S62211**	**Fracture of shaft of first metacarpal bone, open**
fracture	**S62220**	**Fracture of neck of first metacarpal bone, closed**
fracture	**S62221**	**Fracture of neck of first metacarpal bone, open**
fracture	**S62270**	**Fracture of multiple sites of first metacarpal bones, closed**
fracture	**S62271**	**Fracture of multiple sites of first metacarpal bones, open**
fracture	**S62290**	**Fracture of unspecified site of first metacarpal bone, closed**
fracture	**S62291**	**Fracture of unspecified site of first metacarpal bone, open**
fracture	**S62300**	**Fracture of base of other metacarpal bone, closed**

fracture	**S62301**	**Fracture of base of other metacarpal bone, open**
fracture	**S62310**	**Fracture of shaft of other metacarpal bone, closed**
fracture	**S62311**	**Fracture of shaft of other metacarpal bone, open**
fracture	**S62320**	**Fracture of head of other metacarpal bone, closed**
fracture	**S62321**	**Fracture of head of other metacarpal bone, open**
fracture	**S62370**	**Fracture of multiple sites of other metacarpal bone, closed**
fracture	**S62371**	**Fracture of multiple sites of other metacarpal bone, open**
fracture	**S62390**	**Fracture of unspecified site of other metacarpal bone, closed**
fracture	**S62391**	**Fracture of unspecified site of other metacarpal bone, open**
fracture	**S62400**	**Multiple fractures of base of other metacarpal bones, closed**
fracture	**S62401**	**Multiple fractures of base of other metacarpal bones, open**
fracture	**S62410**	**Multiple fractures of shaft of other metacarpal bones, closed**
fracture	**S62411**	**Multiple fractures of shaft of other metacarpal bones, open**
fracture	**S62420**	**Multiple fractures of head of other metacarpal bones, closed**
fracture	**S62421**	**Multiple fractures of head of other metacarpal bones, open**
fracture	**S62470**	**Multiple fractures of multiple sites of other metacarpal bones, closed**
fracture	**S62471**	**Multiple fractures of multiple sites of other metacarpal bones, open**
fracture	**S62490**	**Multiple fractures unspecified site of other metacarpal bones, closed**
fracture	**S62491**	**Multiple fractures unspecified site of other metacarpal bones, open**
fracture	**S62800**	**Fracture of other and unspecified parts of wrist and hand, closed**
fracture	**S62801**	**Fracture of other and unspecified parts of wrist and hand, open**
fracture	**T100**	**Fracture of upper limb, level unspecified, closed**
ligamentous injury	**S532**	**Traumatic rupture of radial collateral ligament**

ligamentous injury	**S533**	**Traumatic rupture of ulnar collateral ligament**
ligamentous injury	**S5340**	**Sprain and strain of radial collateral ligament**
ligamentous injury	**S5341**	**Sprain and strain of ulnar collateral ligament**
ligamentous injury	**S5342**	**Sprain and strain of radiohumeral (joint)**
ligamentous injury	**S5343**	**Sprain and strain of ulnohumeral (joint)**
ligamentous injury	**S5348**	**Other sprain and strain of elbow**
ligamentous injury	**S5349**	**Unspecified sprain and strain of elbow**
ligamentous injury	**S6360**	**Sprain and strain of interphalangeal (joint) of finger(s)**
ligamentous injury	**S6361**	**Sprain and strain of metacarpophalangeal (joint) of finger(s)**
ligamentous injury	**S6368**	**Other sprain and strain of finger(s)**
ligamentous injury	**S6369**	**Unspecified sprain and strain of finger(s)**
ligamentous injury	**S633**	**Traumatic rupture of ligament of wrist and carpus**
ligamentous injury	**S634**	**Traumatic rupture of ligament of finger at metacarpophalangeal and interphalangeal joint(s)**
ligamentous injury	**S6350**	**Sprain and strain of carpal (joint) of wrist**
ligamentous injury	**S6351**	**Sprain and strain of radiocarpal (joint)(ligament) of wrist**
ligamentous	**S6358**	**Other sprain and strain of wrist**

injury		
ligamentous injury	**S6359**	**Unspecified sprain and strain of wrist**
ligamentous injury	**S6370**	**Sprain and strain of carpometacarpal (joint) of hand**
ligamentous injury	**S6371**	**Sprain and strain of metacarpal (distal) (proximal)**
ligamentous injury	**S6372**	**Midcarpal sprain and strain of hand**
ligamentous injury	**S6378**	**Sprain and strain of other parts of hand**
ligamentous injury	**S6379**	**Sprain and strain of unspecified parts of hand**
nerve	**S4400**	**Laceration of ulnar nerve at upper arm level**
nerve	**S4408**	**Other and unspecified injury of ulnar nerve at upper arm level**
nerve	**S4418**	**Other and unspecified injury of median nerve at upper arm level**
nerve	**S4478**	**Other and unspecified injury of multiple nerves at shoulder and upper arm level**
nerve	**S4488**	**Other and unspecified injury of other nerves at shoulder and upper arm level**
nerve	**S4498**	**Other and unspecified injury of unspecified nerve at shoulder and upper arm level**
nerve	**S6430**	**Laceration of digital nerve of thumb**
nerve	**S6438**	**Other and unspecified injury of digital nerve of thumb**
nerve	**S6440**	**Laceration of digital nerve of other finger**
nerve	**S6448**	**Other and unspecified injury of digital nerve of other finger**
nerve	**S5400**	**Laceration of ulnar nerve at forearm level**
nerve	**S5408**	**Other and unspecified ulnar nerve injury at forearm level**

nerve	**S5410**	**Laceration of median nerve at forearm level**
nerve	**S5418**	**Other and unspecified median nerve injury at forearm level**
nerve	**S5420**	**Laceration of radial nerve at forearm level**
nerve	**S5428**	**Other and unspecified radial nerve injury at forearm level**
nerve	**S5430**	**Laceration of cutaneous sensory nerve at forearm level**
nerve	**S5438**	**Other and unspecified cutaneous sensory nerve injury at forearm level**
nerve	**S5470**	**Laceration of multiple nerves at forearm level**
nerve	**S5478**	**Other and unspecified injury of multiple nerves at forearm level**
nerve	**S5480**	**Laceration of other nerves at forearm level**
nerve	**S5488**	**Other and unspecified nerve injury of other nerves at forearm level**
nerve	**S5490**	**Laceration of unspecified nerve at forearm level**
nerve	**S5498**	**Other and unspecified nerve injury of unspecified nerves at forearm level**
nerve	**S6400**	**Laceration of ulnar nerve at wrist and hand level**
nerve	**S6408**	**Other and unspecified injury of ulnar nerve at wrist and hand level**
nerve	**S6410**	**Laceration of median nerve at wrist and hand level**
nerve	**S6418**	**Other and unspecified injury of median nerve at wrist and hand level**
nerve	**S6420**	**Laceration of radial nerve at wrist and hand level**
nerve	**S6428**	**Other and unspecified injury of radial nerve at wrist and hand level**
nerve	**S6470**	**Laceration of multiple nerves at wrist and hand level**
nerve	**S6478**	**Other specified injury of multiple nerves at wrist and hand level**
nerve	**S6480**	**Laceration of other nerves at wrist and hand level**
nerve	**S6488**	**Other and unspecified injury of other nerves at wrist & hand**
nerve	**S6490**	**Laceration of unspecified nerve at wrist and hand level**

nerve	**S6498**	**Other and unspecified injury of unspecified nerves at wrist and hand level**
nerve	**S1438**	**Other and unspecified injury of brachial plexus**
nerve	**S4428**	**Other and unspecified injury of radial nerve at upper arm level**
nerve	**S4438**	**Other and unspecified injury of axillary nerve**
nerve	**S4448**	**Other and unspecified injury of musculocutaneous nerve**
nerve	**T113**	**Injury of unspecified nerve of upper limb, level unspecified**
wound	**S5100**	**Open wound of elbow, uncomplicated**
wound	**S5101**	**Open wound of elbow, complicated**
other MSK injury	**S602**	**Contusion of other parts of wrist and hand**
other MSK injury	**S697**	**Multiple injuries of wrist and hand**
other MSK injury	**S698**	**Other specified injuries of wrist and hand**
other MSK injury	**S699**	**Unspecified injury of wrist and hand**
other MSK injury	**T118**	**Other specified injuries of upper limb, level unspecified**
other MSK injury	**T119**	**Unspecified injury of upper limb, level unspecified**
tendon	**S6600**	**Laceration of long flexor muscle and tendon of thumb at wrist and hand level**
tendon	**S6608**	**Other and unspecified injury of long flexor muscle and tendon of thumb at wrist and hand level**
tendon	**S6610**	**Laceration of flexor muscle and tendon of other finger at wrist and hand level**
tendon	**S6618**	**Other and unspecified injury of flexor muscle and tendon of other finger at wrist and hand level**
tendon	**S6628**	**Other and unspecified injury of extensor muscle and tendon of thumb at wrist and hand level**
tendon	**S6638**	**Other and unspecified injury of extensor muscle and tendon of other finger at wrist and hand level**
tendon	**S6648**	**Other and unspecified injury of intrinsic muscle and tendon of**

		thumb at wrist and hand level
tendon	**S6658**	**Other and unspecified injury of intrinsic muscle and tendon of other finger at wrist and hand level**
tendon	**S5600**	**Laceration of flexor muscle and tendon of thumb at forearm level**
tendon	**S5608**	**Other and unspecified injury of flexor muscle and tendon of thumb at forearm level**
tendon	**S5610**	**Laceration of long flexor muscle and tendon of other finger(s) at forearm level**
tendon	**S5618**	**Other and unspecified injury of long flexor muscle and tendon of other finger(s) at forearm level**
tendon	**S5620**	**Laceration of other flexor muscle and tendon at forearm level**
tendon	**S5628**	**Other and unspecified injury of other flexor muscle and tendon at forearm level**
tendon	**S5630**	**Laceration of extensor or abductor muscles and tendons of thumb at forearm level**
tendon	**S5638**	**Other and unspecified injury of extensor or abductor muscles and tendons of thumb at forearm level**
tendon	**S5640**	**Laceration of extensor muscle and tendon of other finger(s) at forearm level**
tendon	**S5648**	**Other and unspecified injury of extensor muscle and tendon of other finger(s) at forearm level**
tendon	**S5650**	**Laceration of other extensor muscle and tendon at forearm level**
tendon	**S5658**	**Other and unspecified injury of other extensor muscle and tendon at forearm level**
tendon	**S5670**	**Laceration of multiple muscles and tendons at forearm level**
tendon	**S5678**	**Other and unspecified injury of multiple muscles and tendons at forearm level**
tendon	**S5680**	**Laceration of other and unspecified muscles and tendons at forearm level**
tendon	**S5688**	**Other and unspecified injury of other and unspecified muscles and tendons at forearm level**

tendon	**S6620**	**Laceration of extensor muscle and tendon of thumb at wrist and hand level**
tendon	**S6630**	**Laceration of extensor muscle and tendon of other finger at wrist and hand level**
tendon	**S6640**	**Laceration of intrinsic muscle and tendon of thumb at wrist and hand level**
tendon	**S6650**	**Laceration of intrinsic muscle and tendon of other finger at wrist and hand level**
tendon	**S6660**	**Laceration of multiple flexor muscles and tendons at wrist and hand level**
tendon	**S6668**	**Other and unspecified injury of multiple flexor muscles and tendons at wrist and hand level**
tendon	**S6670**	**Laceration of multiple extensor muscles and tendons at wrist and hand level**
tendon	**S6678**	**Other and unspecified of multiple extensor muscles and tendons at wrist and hand level**
tendon	**S6680**	**Laceration of other muscles and tendons at wrist and hand level**
tendon	**S6688**	**Other and unspecified injury of other muscles and tendons at wrist and hand level**
tendon	**S6690**	**Laceration of unspecified muscle and tendon at wrist and hand level**
tendon	**S6698**	**Other and unspecified injury of unspecified muscle and tendon at wrist and hand level**
tendon	**T115**	**Injury of unspecified muscle and tendon of upper limb, level unspecified**
unspecified	**S597**	**Multiple injuries of forearm**
unspecified	**S598**	**Other specified injuries of forearm**
unspecified	**S599**	**Unspecified injury of forearm**
vascular injury	**S654**	**Injury of blood vessel(s) of thumb**
vascular injury	**S655**	**Injury of blood vessel(s) of other finger**
vascular injury	**S550**	**Injury of ulnar artery at forearm level**

vascular injury	**S551**	**Injury of radial artery at forearm level**
vascular injury	**S552**	**Injury of vein at forearm level**
vascular injury	**S557**	**Injury of multiple blood vessels at forearm level**
vascular injury	**S558**	**Injury of other blood vessels at forearm level**
vascular injury	**S559**	**Injury of unspecified blood vessel at forearm level**
vascular injury	**S650**	**Injury of ulnar artery at wrist and hand level**
vascular injury	**S651**	**Injury of radial artery at wrist and hand level**
vascular injury	**S652**	**Injury of superficial palmar arch**
vascular injury	**S653**	**Injury of deep palmar arch**
vascular injury	**S657**	**Injury of multiple blood vessels at wrist and hand level**
vascular injury	**S658**	**Injury of other blood vessels at wrist and hand level**
vascular injury	**S659**	**Injury of unspecified blood vessel at wrist and hand level**
vascular injury	**T114**	**Injury of unspecified blood vessel of upper limb, level unspecified**
wound	**S600**	**Contusion of finger(s) without damage to nail**
wound	**S601**	**Contusion of finger(s) with damage to nail**
wound	**S6100**	**Open wound of finger(s) without damage to nail, uncomplicated**
wound	**S6101**	**Open wound of finger(s) without damage to nail, complicated**
wound	**S6110**	**Open wound of finger(s) with damage to nail, uncomplicated**
wound	**S6111**	**Open wound of finger(s) with damage to nail, complicated**
wound	**S5170**	**Open wound of forearm, multiple, uncomplicated**
wound	**S5171**	**Open wound of forearm, multiple, complicated**
wound	**S5180**	**Open wound of other parts of forearm, uncomplicated**
wound	**S5181**	**Open wound of other parts of forearm, complicated**
wound	**S5190**	**Open wound of forearm, part unspecified, uncomplicated**

wound	**S5191**	**Open wound of forearm, part unspecified, complicated**
wound	**S607**	**Multiple superficial injuries of wrist and hand**
wound	**S608**	**Other superficial injuries of wrist and hand**
wound	**S609**	**Unspecified superficial injury of wrist and hand**
wound	**S6170**	**Multiple open wounds of wrist and hand, uncomplicated**
wound	**S6171**	**Multiple open wounds of wrist and hand, complicated**
wound	**S6180**	**Open wound of other parts of wrist and hand, uncomplicated**
wound	**S6181**	**Open wound of other parts of wrist and hand, complicated**
wound	**S6190**	**Open wound of wrist and hand part, part unspecified, uncomplicated**
wound	**S6191**	**Open wound of wrist and hand part, part unspecified, complicated**
wound	**T110**	**Superficial injury of upper limb, level unspecified**
wound	**T111**	**Open wound of upper limb, level unspecified**

Appendix 2.5: Classification of ICD-10 code by injury level.

Injury Level	**ICD-10 Diagnostic Code**	**Diagnostic Code Description**
arm	**S4400**	**Laceration of ulnar nerve at upper arm level**
arm	**S4408**	**Other and unspecified injury of ulnar nerve at upper arm level**
arm	**S4418**	**Other and unspecified injury of median nerve at upper arm level**

arm	**S4478**	**Other and unspecified injury of multiple nerves at shoulder and upper arm level**
arm	**S4488**	**Other and unspecified injury of other nerves at shoulder and upper arm level**
arm	**S4498**	**Other and unspecified injury of unspecified nerve at shoulder and upper arm level**
arm	**S473**	**Crushing injury of upper arm**
arm	**S477**	**Crushing injury of multiple sites of shoulder & upper arm**
arm	**S478**	**Crushing injury of other specified parts of shoulder & upper arm**
arm	**S489**	**Traumatic amputation of shoulder and upper arm, level unspecified**
elbow	**S5100**	**Open wound of elbow, uncomplicated**
elbow	**S5101**	**Open wound of elbow, complicated**
elbow	**S52000**	**Fracture of olecranon process of ulna, closed**
elbow	**S52001**	**Fracture of olecranon process of ulna, open**
elbow	**S52010**	**Fracture of coronoid process of ulna, closed**
elbow	**S53100**	**Anterior dislocation of elbow, closed**
elbow	**S53110**	**Posterior dislocation of elbow, closed**
elbow	**S53111**	**Posterior dislocation of elbow, open**
elbow	**S53120**	**Medial dislocation of elbow, closed**
elbow	**S53130**	**Lateral dislocation of elbow, closed**
elbow	**S53180**	**Other dislocation of elbow, closed**
elbow	**S53181**	**Other dislocation of elbow, open**
elbow	**S53190**	**Unspecified dislocation of elbow, closed**
elbow	**S53191**	**Unspecified dislocation of elbow, open**
elbow	**S532**	**Traumatic rupture of radial collateral ligament**

elbow	**S533**	**Traumatic rupture of ulnar collateral ligament**
elbow	**S5340**	**Sprain and strain of radial collateral ligament**
elbow	**S5341**	**Sprain and strain of ulnar collateral ligament**
elbow	**S5342**	**Sprain and strain of radiohumeral (joint)**
elbow	**S5343**	**Sprain and strain of ulnohumeral (joint)**
elbow	**S5348**	**Other sprain and strain of elbow**
elbow	**S5349**	**Unspecified sprain and strain of elbow**
elbow	**S570**	**Crushing injury of elbow**
elbow	**S580**	**Traumatic amputation at elbow level**
finger	**S600**	**Contusion of finger(s) without damage to nail**
finger	**S601**	**Contusion of finger(s) with damage to nail**
finger	**S6100**	**Open wound of finger(s) without damage to nail, uncomplicated**
finger	**S6101**	**Open wound of finger(s) without damage to nail, complicated**
finger	**S6110**	**Open wound of finger(s) with damage to nail, uncomplicated**
finger	**S6111**	**Open wound of finger(s) with damage to nail, complicated**
finger	**S62500**	**Fracture of proximal phalanx, closed**
finger	**S62501**	**Fracture of proximal phalanx, open**
finger	**S62510**	**Fracture of distal phalanx, closed**
finger	**S62511**	**Fracture of distal phalanx, open**
finger	**S62570**	**Fracture of multiple sites of thumb, closed**
finger	**S62571**	**Fracture of multiple sites of thumb, open**
finger	**S62590**	**Fracture of unspecified part of phalanx, closed**
finger	**S62591**	**Fracture of unspecified part of phalanx, open**
finger	**S62600**	**Fracture of middle or proximal phalanx of finger, closed**

finger	**S62601**	**Fracture of middle or proximal phalanx of finger, open**
finger	**S62610**	**Fracture of distal phalanx of finger, closed**
finger	**S62611**	**Fracture of distal phalanx of finger, open**
finger	**S62670**	**Fracture of multiple sites of finger, closed**
finger	**S62671**	**Fracture of multiple sites of finger, open**
finger	**S62690**	**Fracture of unspecified part of phalanx of finger, closed**
finger	**S62691**	**Fracture of unspecified part of phalanx of finger, open**
finger	**S62700**	**Multiple fractures of fingers, closed**
finger	**S62701**	**Multiple fractures of fingers, open**
finger	**S63100**	**Dislocation of metacarpophalangeal (joint) of finger, closed**
finger	**S63101**	**Dislocation of metacarpophalangeal (joint) of finger, open**
finger	**S63110**	**Dislocation of interphalangeal (joint) of finger, closed**
finger	**S63111**	**Dislocation of interphalangeal (joint) of finger, open**
finger	**S63180**	**Other dislocation of finger, closed**
finger	**S63181**	**Other dislocation of finger, open**
finger	**S63190**	**Unspecified dislocation of finger, closed**
finger	**S63191**	**Unspecified dislocation of finger, open**
finger	**S63200**	**Multiple dislocations of fingers, closed**
finger	**S63201**	**Multiple dislocations of fingers, open**
finger	**S6360**	**Sprain and strain of interphalangeal (joint) of finger(s)**
finger	**S6361**	**Sprain and strain of metacarpophalangeal (joint) of finger(s)**
finger	**S6368**	**Other sprain and strain of finger(s)**
finger	**S6369**	**Unspecified sprain and strain of finger(s)**
finger	**S6430**	**Laceration of digital nerve of thumb**

finger	**S6438**	**Other and unspecified injury of digital nerve of thumb**
finger	**S6440**	**Laceration of digital nerve of other finger**
finger	**S6448**	**Other and unspecified injury of digital nerve of other finger**
finger	**S654**	**Injury of blood vessel(s) of thumb**
finger	**S655**	**Injury of blood vessel(s) of other finger**
finger	**S6600**	**Laceration of long flexor muscle and tendon of thumb at wrist and hand level**
finger	**S6608**	**Other and unspecified injury of long flexor muscle and tendon of thumb at wrist and hand level**
finger	**S6610**	**Laceration of flexor muscle and tendon of other finger at wrist and hand level**
finger	**S6618**	**Other and unspecified injury of flexor muscle and tendon of other finger at wrist and hand level**
finger	**S6628**	**Other and unspecified injury of extensor muscle and tendon of thumb at wrist and hand level**
finger	**S6638**	**Other and unspecified injury of extensor muscle and tendon of other finger at wrist and hand level**
finger	**S6648**	**Other and unspecified injury of intrinsic muscle and tendon of thumb at wrist and hand level**
finger	**S6658**	**Other and unspecified injury of intrinsic muscle and tendon of other finger at wrist and hand level**
finger	**S670**	**Crushing injury of thumb and other finger(s)**
finger	**S681**	**Traumatic amputation of other single finger (complete)(partial)**
finger	**S682**	**Traumatic amputation of two or more fingers alone (complete)(partial)**
finger	**S683**	**Combined traumatic amputation of (part of) finger(s) with other parts of wrist and hand**
forearm	**S5170**	**Open wound of forearm, multiple, uncomplicated**
forearm	**S5171**	**Open wound of forearm, multiple, complicated**

forearm	**S5180**	**Open wound of other parts of forearm, uncomplicated**
forearm	**S5181**	**Open wound of other parts of forearm, complicated**
forearm	**S5190**	**Open wound of forearm, part unspecified, uncomplicated**
forearm	**S5191**	**Open wound of forearm, part unspecified, complicated**
forearm	**S52020**	**Monteggia's fracture, closed**
forearm	**S52021**	**Monteggia's fracture, open**
forearm	**S52080**	**Other/multiple fractures of upper end of ulna, closed**
forearm	**S52081**	**Other/multiple fractures of upper end of ulna, open**
forearm	**S52090**	**Unspecified fracture of upper end of ulna, closed**
forearm	**S52091**	**Unspecified fracture of upper end of ulna, open**
forearm	**S52100**	**Fracture of head of radius, closed**
forearm	**S52101**	**Fracture of head of radius, open**
forearm	**S52110**	**Fracture of neck of radius, closed**
forearm	**S52111**	**Fracture of neck of radius, open**
forearm	**S52120**	**Fracture of radius with ulna, upper end, closed**
forearm	**S52121**	**Fracture of radius with ulna, upper end, open**
forearm	**S52180**	**Other/multiple fracture of upper end of radius, closed**
forearm	**S52181**	**Other/multiple fracture of upper end of radius, open**
forearm	**S52190**	**Unspecified fracture of upper end of radius, closed**
forearm	**S52191**	**Unspecified fracture of upper end of radius, open**
forearm	**S52200**	**Fracture of shaft of ulna, closed**
forearm	**S52201**	**Fracture of shaft of ulna, open**
forearm	**S52300**	**Fracture of shaft of radius, closed**
forearm	**S52301**	**Fracture of shaft of radius, open**

forearm	**S52400**	**Fracture of shafts of both ulna and radius, closed**
forearm	**S52401**	**Fracture of shafts of both ulna and radius, open**
forearm	**S52700**	**Multiple fractures of forearm, closed**
forearm	**S52701**	**Multiple fractures of forearm, open**
forearm	**S52800**	**Fracture of other parts of forearm, closed**
forearm	**S52801**	**Fracture of other parts of forearm, open**
forearm	**S52900**	**Fracture of forearm, part unspecified, closed**
forearm	**S52901**	**Fracture of forearm, part unspecified, open**
forearm	**S530**	**Dislocation of radial head**
forearm	**S5400**	**Laceration of ulnar nerve at forearm level**
forearm	**S5408**	**Other and unspecified ulnar nerve injury at forearm level**
forearm	**S5410**	**Laceration of median nerve at forearm level**
forearm	**S5418**	**Other and unspecified median nerve injury at forearm level**
forearm	**S5420**	**Laceration of radial nerve at forearm level**
forearm	**S5428**	**Other and unspecified radial nerve injury at forearm level**
forearm	**S5430**	**Laceration of cutaneous sensory nerve at forearm level**
forearm	**S5438**	**Other and unspecified cutaneous sensory nerve injury at forearm level**
forearm	**S5470**	**Laceration of multiple nerves at forearm level**
forearm	**S5478**	**Other and unspecified injury of multiple nerves at forearm level**
forearm	**S5480**	**Laceration of other nerves at forearm level**
forearm	**S5488**	**Other and unspecified nerve injury of other nerves at forearm level**
forearm	**S5490**	**Laceration of unspecified nerve at forearm level**
forearm	**S5498**	**Other and unspecified nerve injury of unspecified nerves at forearm level**

forearm	**S550**	**Injury of ulnar artery at forearm level**
forearm	**S551**	**Injury of radial artery at forearm level**
forearm	**S552**	**Injury of vein at forearm level**
forearm	**S557**	**Injury of multiple blood vessels at forearm level**
forearm	**S558**	**Injury of other blood vessels at forearm level**
forearm	**S559**	**Injury of unspecified blood vessel at forearm level**
forearm	**S5600**	**Laceration of flexor muscle and tendon of thumb at forearm level**
forearm	**S5608**	**Other and unspecified injury of flexor muscle and tendon of thumb at forearm level**
forearm	**S5610**	**Laceration of long flexor muscle and tendon of other finger(s) at forearm level**
forearm	**S5618**	**Other and unspecified injury of long flexor muscle and tendon of other finger(s) at forearm level**
forearm	**S5620**	**Laceration of other flexor muscle and tendon at forearm level**
forearm	**S5628**	**Other and unspecified injury of other flexor muscle and tendon at forearm level**
forearm	**S5630**	**Laceration of extensor or abductor muscles and tendons of thumb at forearm level**
forearm	**S5638**	**Other and unspecified injury of extensor or abductor muscles and tendons of thumb at forearm level**
forearm	**S5640**	**Laceration of extensor muscle and tendon of other finger(s) at forearm level**
forearm	**S5648**	**Other and unspecified injury of extensor muscle and tendon of other finger(s) at forearm level**
forearm	**S5650**	**Laceration of other extensor muscle and tendon at forearm level**
forearm	**S5658**	**Other and unspecified injury of other extensor muscle and tendon at forearm level**
forearm	**S5670**	**Laceration of multiple muscles and tendons at forearm level**
forearm	**S5678**	**Other and unspecified injury of multiple muscles and tendons at**

		forearm level
forearm	**S5680**	**Laceration of other and unspecified muscles and tendons at forearm level**
forearm	**S5688**	**Other and unspecified injury of other and unspecified muscles and tendons at forearm level**
forearm	**S578**	**Crushing injury of other parts of forearm**
forearm	**S579**	**Crushing injury of forearm, part unspecified**
forearm	**S581**	**Traumatic amputation at level between elbow and wrist**
forearm	**S589**	**Traumatic amputation of forearm, level unspecified**
forearm	**S597**	**Multiple injuries of forearm**
forearm	**S598**	**Other specified injuries of forearm**
forearm	**S599**	**Unspecified injury of forearm**
hand and wrist	**S52500**	**Colles' fracture, closed**
hand and wrist	**S52501**	**Colles' fracture, open**
hand and wrist	**S52580**	**Other fracture of lower end of radius, closed**
hand and wrist	**S52581**	**Other fracture of lower end of radius, open**
hand and wrist	**S52590**	**Unspecified fracture of lower end of radius, closed**
hand and wrist	**S52591**	**Unspecified fracture of lower end of radius, open**
hand and wrist	**S52600**	**Fracture of lower end of both ulna and radius, closed**
hand and wrist	**S52601**	**Fracture of lower end of both ulna and radius, open**
hand and	**S602**	**Contusion of other parts of wrist and hand**

wrist		
hand and wrist	**S607**	**Multiple superficial injuries of wrist and hand**
hand and wrist	**S608**	**Other superficial injuries of wrist and hand**
hand and wrist	**S609**	**Unspecified superficial injury of wrist and hand**
hand and wrist	**S6170**	**Multiple open wounds of wrist and hand, uncomplicated**
hand and wrist	**S6171**	**Multiple open wounds of wrist and hand, complicated**
hand and wrist	**S6180**	**Open wound of other parts of wrist and hand, uncomplicated**
hand and wrist	**S6181**	**Open wound of other parts of wrist and hand, complicated**
hand and wrist	**S6190**	**Open wound of wrist and hand part, part unspecified, uncomplicated**
hand and wrist	**S6191**	**Open wound of wrist and hand part, part unspecified, complicated**
hand and wrist	**S62000**	**Fracture of navicular [scaphoid] bone of hand, closed**
hand and wrist	**S62001**	**Fracture of navicular [scaphoid] bone of hand, open**
hand and wrist	**S62100**	**Fracture of lunate bone, closed**
hand and wrist	**S62101**	**Fracture of lunate bone, open**
hand and wrist	**S62110**	**Fracture of triquetral bone, closed**
hand and wrist	**S62111**	**Fracture of triquetral bone, open**

hand and wrist	**S62120**	**Fracture of pisiform bone, closed**
hand and wrist	**S62130**	**Fracture of trapezium bone, closed**
hand and wrist	**S62131**	**Fracture of trapezium bone, open**
hand and wrist	**S62140**	**Fracture of trapezoid bone, closed**
hand and wrist	**S62150**	**Fracture of capitate bone, closed**
hand and wrist	**S62160**	**Fracture of hamate bone, closed**
hand and wrist	**S62180**	**Fracture of other carpal bones, closed**
hand and wrist	**S62181**	**Fracture of other carpal bones, open**
hand and wrist	**S62190**	**Fracture of unspecified carpal bones, closed**
hand and wrist	**S62191**	**Fracture of unspecified carpal bones, open**
hand and wrist	**S62200**	**Fracture of base of first metacarpal bone, closed**
hand and wrist	**S62201**	**Fracture of base of first metacarpal bone, open**
hand and wrist	**S62210**	**Fracture of shaft of first metacarpal bone, closed**
hand and wrist	**S62211**	**Fracture of shaft of first metacarpal bone, open**
hand and wrist	**S62220**	**Fracture of neck of first metacarpal bone, closed**
hand and	**S62221**	**Fracture of neck of first metacarpal bone, open**

wrist		
hand and wrist	**S62270**	**Fracture of multiple sites of first metacarpal bones, closed**
hand and wrist	**S62271**	**Fracture of multiple sites of first metacarpal bones, open**
hand and wrist	**S62290**	**Fracture of unspecified site of first metacarpal bone, closed**
hand and wrist	**S62291**	**Fracture of unspecified site of first metacarpal bone, open**
hand and wrist	**S62300**	**Fracture of base of other metacarpal bone, closed**
hand and wrist	**S62301**	**Fracture of base of other metacarpal bone, open**
hand and wrist	**S62310**	**Fracture of shaft of other metacarpal bone, closed**
hand and wrist	**S62311**	**Fracture of shaft of other metacarpal bone, open**
hand and wrist	**S62320**	**Fracture of head of other metacarpal bone, closed**
hand and wrist	**S62321**	**Fracture of head of other metacarpal bone, open**
hand and wrist	**S62370**	**Fracture of multiple sites of other metacarpal bone, closed**
hand and wrist	**S62371**	**Fracture of multiple sites of other metacarpal bone, open**
hand and wrist	**S62390**	**Fracture of unspecified site of other metacarpal bone, closed**
hand and wrist	**S62391**	**Fracture of unspecified site of other metacarpal bone, open**
hand and wrist	**S62400**	**Multiple fractures of base of other metacarpal bones, closed**

hand and wrist	**S62401**	**Multiple fractures of base of other metacarpal bones, open**
hand and wrist	**S62410**	**Multiple fractures of shaft of other metacarpal bones, closed**
hand and wrist	**S62411**	**Multiple fractures of shaft of other metacarpal bones, open**
hand and wrist	**S62420**	**Multiple fractures of head of other metacarpal bones, closed**
hand and wrist	**S62421**	**Multiple fractures of head of other metacarpal bones, open**
hand and wrist	**S62470**	**Multiple fractures of multiple sites of other metacarpal bones, closed**
hand and wrist	**S62471**	**Multiple fractures of multiple sites of other metacarpal bones, open**
hand and wrist	**S62490**	**Multiple fractures unspecified site of other metacarpal bones, closed**
hand and wrist	**S62491**	**Multiple fractures unspecified site of other metacarpal bones, open**
hand and wrist	**S62800**	**Fracture of other and unspecified parts of wrist and hand, closed**
hand and wrist	**S62801**	**Fracture of other and unspecified parts of wrist and hand, open**
hand and wrist	**S63000**	**Dislocation of radioulnar (joint) distal, closed**
hand and wrist	**S63010**	**Dislocation of radiocarpal (joint), closed**
hand and wrist	**S63020**	**Dislocation of midcarpal (joint), closed**
hand and wrist	**S63030**	**Dislocation of carpometacarpal (joint), closed**
hand and	**S63040**	**Dislocation of metacarpal (bone) proximal end, closed**

wrist		
hand and wrist	**S63041**	**Dislocation of metacarpal (bone) proximal end, open**
hand and wrist	**S63080**	**Other dislocation of wrist, closed**
hand and wrist	**S63090**	**Unspecified dislocation of wrist, closed**
hand and wrist	**S63091**	**Unspecified dislocation of wrist, open**
hand and wrist	**S633**	**Traumatic rupture of ligament of wrist and carpus**
hand and wrist	**S634**	**Traumatic rupture of ligament of finger at metacarpophalangeal and interphalangeal joint(s)**
hand and wrist	**S6350**	**Sprain and strain of carpal (joint) of wrist**
hand and wrist	**S6351**	**Sprain and strain of radiocarpal (joint)(ligament) of wrist**
hand and wrist	**S6358**	**Other sprain and strain of wrist**
hand and wrist	**S6359**	**Unspecified sprain and strain of wrist**
hand and wrist	**S6370**	**Sprain and strain of carpometacarpal (joint) of hand**
hand and wrist	**S6371**	**Sprain and strain of metacarpal (distal) (proximal)**
hand and wrist	**S6372**	**Midcarpal sprain and strain of hand**
hand and wrist	**S6378**	**Sprain and strain of other parts of hand**
hand and wrist	**S6379**	**Sprain and strain of unspecified parts of hand**

hand and wrist	**S6400**	**Laceration of ulnar nerve at wrist and hand level**
hand and wrist	**S6408**	**Other and unspecified injury of ulnar nerve at wrist and hand level**
hand and wrist	**S6410**	**Laceration of median nerve at wrist and hand level**
hand and wrist	**S6418**	**Other and unspecified injury of median nerve at wrist and hand level**
hand and wrist	**S6420**	**Laceration of radial nerve at wrist and hand level**
hand and wrist	**S6428**	**Other and unspecified injury of radial nerve at wrist and hand level**
hand and wrist	**S6470**	**Laceration of multiple nerves at wrist and hand level**
hand and wrist	**S6478**	**Other specified injury of multiple nerves at wrist and hand level**
hand and wrist	**S6480**	**Laceration of other nerves at wrist and hand level**
hand and wrist	**S6488**	**Other and unspecified injury of other nerves at wrist & hand**
hand and wrist	**S6490**	**Laceration of unspecified nerve at wrist and hand level**
hand and wrist	**S6498**	**Other and unspecified injury of unspecified nerves at wrist and hand level**
hand and wrist	**S650**	**Injury of ulnar artery at wrist and hand level**
hand and wrist	**S651**	**Injury of radial artery at wrist and hand level**
hand and wrist	**S652**	**Injury of superficial palmar arch**
hand and	**S653**	**Injury of deep palmar arch**

wrist		
hand and wrist	**S657**	**Injury of multiple blood vessels at wrist and hand level**
hand and wrist	**S658**	**Injury of other blood vessels at wrist and hand level**
hand and wrist	**S659**	**Injury of unspecified blood vessel at wrist and hand level**
hand and wrist	**S6620**	**Laceration of extensor muscle and tendon of thumb at wrist and hand level**
hand and wrist	**S6630**	**Laceration of extensor muscle and tendon of other finger at wrist and hand level**
hand and wrist	**S6640**	**Laceration of intrinsic muscle and tendon of thumb at wrist and hand level**
hand and wrist	**S6650**	**Laceration of intrinsic muscle and tendon of other finger at wrist and hand level**
hand and wrist	**S6660**	**Laceration of multiple flexor muscles and tendons at wrist and hand level**
hand and wrist	**S6668**	**Other and unspecified injury of multiple flexor muscles and tendons at wrist and hand level**
hand and wrist	**S6670**	**Laceration of multiple extensor muscles and tendons at wrist and hand level**
hand and wrist	**S6678**	**Other and unspecified of multiple extensor muscles and tendons at wrist and hand level**
hand and wrist	**S6680**	**Laceration of other muscles and tendons at wrist and hand level**
hand and wrist	**S6688**	**Other and unspecified injury of other muscles and tendons at wrist and hand level**
hand and wrist	**S6690**	**Laceration of unspecified muscle and tendon at wrist and hand level**
hand and wrist	**S6698**	**Other and unspecified injury of unspecified muscle and tendon at wrist and hand level**

hand and wrist	**S678**	**Crushing injury of other and unspecified parts of wrist and hand**
hand and wrist	**S680**	**Traumatic amputation of thumb (complete)(partial)**
hand and wrist	**S684**	**Traumatic amputation of hand at wrist level**
hand and wrist	**S688**	**Traumatic amputation of other parts of wrist and hand**
hand and wrist	**S689**	**Traumatic amputation of wrist and hand, level unspecified**
hand and wrist	**S697**	**Multiple injuries of wrist and hand**
hand and wrist	**S698**	**Other specified injuries of wrist and hand**
hand and wrist	**S699**	**Unspecified injury of wrist and hand**
hand and wrist	**T230**	**Burn of unspecified degree of wrist and hand**
hand and wrist	**T231**	**Burn of first degree of wrist and hand**
hand and wrist	**T232**	**Burn of second degree of wrist and hand**
hand and wrist	**T233**	**Burn of third degree of wrist and hand**
hand and wrist	**T234**	**Corrosion of unspecified degree of wrist and hand**
hand and wrist	**T235**	**Corrosion of first degree of wrist and hand**
hand and wrist	**T236**	**Corrosion of second degree of wrist and hand**
hand and	**T237**	**Corrosion of third degree of wrist and hand**

wrist		
multiple level	**S612**	**Avulsion, finger, hand, wrist**
shoulder	**S1438**	**Other and unspecified injury of brachial plexus**
shoulder	**S470**	**Crushing injury of shoulder region**
shoulder	**S471**	**Crushing injury of scapular region**
shoulder	**T220**	**Burn of unspecified degree of shoulder and upper limb, except wrist and hand**
shoulder	**T221**	**Burn of first degree of shoulder and upper limb, except wrist and hand**
shoulder	**T222**	**Burn of second degree of shoulder and upper limb, except wrist and hand**
shoulder	**T223**	**Burn of third degree of shoulder and upper limb, except wrist and hand**
shoulder	**T224**	**Corrosion of unspecified degree of shoulder and upper limb, except wrist and hand**
shoulder	**T225**	**Corrosion of first degree of shoulder and upper limb, except wrist and hand**
shoulder	**T226**	**Corrosion of second degree of shoulder and upper limb, except wrist and hand**
shoulder	**T227**	**Corrosion of third degree of shoulder and upper limb, except wrist and hand**
unspecified	**S4428**	**Other and unspecified injury of radial nerve at upper arm level**
unspecified	**S4438**	**Other and unspecified injury of axillary nerve**
unspecified	**S4448**	**Other and unspecified injury of musculocutaneous nerve**
unspecified	**T100**	**Fracture of upper limb, level unspecified, closed**
unspecified	**T110**	**Superficial injury of upper limb, level unspecified**
unspecified	**T111**	**Open wound of upper limb, level unspecified**
unspecified	**T112**	**Dislocation, sprain and strain of unspecified joint and ligament**

		of upper limb, level unspecified
unspecified	**T113**	**Injury of unspecified nerve of upper limb, level unspecified**
unspecified	**T114**	**Injury of unspecified blood vessel of upper limb, level unspecified**
unspecified	**T115**	**Injury of unspecified muscle and tendon of upper limb, level unspecified**
unspecified	**T116**	**Traumatic amputation of upper limb, level unspecified**
unspecified	**T118**	**Other specified injuries of upper limb, level unspecified**
unspecified	**T119**	**Unspecified injury of upper limb, level unspecified**

Appendix 2.6: Privacy Impact Approval from ICES

Privacy Impact Assessment
ICES Project

MANDATORY

PC Administrative Tracking

Event	Date
Receive from PI/FA	February 26, 2018
Forward to PL	March 5, 2018
Receive from PL	March 5, 2018

About this Form: *This ICES Project PIA Form is used to request and document, or amend, approval for the collection and use of ICES Data for an ICES Project. It is current and complete as of the date of Privacy approval below. The exception is amendments that do not involve changes to Project Objectives or requests to add further data to Schedule 1, which are effective upon submission to ICES' Privacy and Compliance Office. Failure to provide all required information will delay approval. Do not use this form to request permission to disclose ICES Data; contact the Privacy and Compliance Office.*

Note on Amendments: *If you are requesting amendments to an existing ICES Project, only provide additional or changed information.*

A. WHY ARE YOU COMPLETING THIS FORM?

To amend approval for an existing ICES Project

What is being amended?

☑ Add an ICES Data Holding	☐ Add an ICES Scientist or ICES Collaborating Researcher
☐ Remove an ICES Data Holding Specify:	☐ Change TRIM number Specify old TRIM:
☐ Change estimated Project Completion	☐ Change Project Objective
☐ Collect additional data for this ICES Project	Other (Specify):

The type of amendment requested requires approval

B. PROJECT

Title (As appears on the PAW)	Long-term health care costs and utilization attributable to hand trauma in Ontario					
TRIM	2018	0990	054	000		
Project Contact	Heather Baltzer				**Email**	heather.baltzer@uhn.ca

C. CHANGES TO PROJECT SUMMARY & OBJECTIVES

Summary (Attach proposal and describe in 50 words or fewer)	☐ Proposal attached		
Project Objectives (Indicate EPM for each objective that will **E**valuate or enable **P**lanning or **M**anagement of the health system or health services in Ontario)	**1.**		*Select*
	2.		*Select*
	3.		*Select*
	4.		*Select*
Anticipated public or scientific benefit (Maximum 50 words)			
Contextual sensitivities or foreseeable harms (Potential to identify, stigmatize or harm any person, group or institution)	☐ None identified	☐ Yes (Identify and suggest mitigation below)	
Estimated Project completion date		**Rapid Response** (Only available for Knowledge User requests that require approval in 1-2 business days. Research Program Coordinator is responsible for obtaining approvals.)	No

D. CHANGES TO PROVIDER REPORTING		
Will the Project result in provider-level reporting about providers of any kind, such as physicians, family health teams or hospitals?	*Select*	
Your response to the following questions will help reviewers understand the potential sensitivity of the reporting and how this will be managed.	What type of provider will be reported on? Examples include physicians, family health teams, pharmacies, long-term care homes and hospitals.	
	Please outline the general nature and content of the reporting. For example, the reporting will benchmark physician prescribing of anti-psychotic medications relative to average prescribing rates among peer physicians.	
	Will individual providers be readily identifiable either by name or through other readily accessible identifiers?	
	Select	
	Who will receive the reporting?	
	How and by whom will it be delivered?	
	How do you plan to manage provider expectations (e.g. by obtaining consent or consulting a representative)? Please attach a copy of any consent form or document.	
		Select

E. CHANGES TO INDIGENOUS DATA ACCESS

(The term Indigenous (or Aboriginal) in Canada includes three groups: First Nations, Métis and Inuit. Refer to the Indigenous Data at ICES intranet page prior to completing this section.)

Will the Project identify (directly or indirectly) any of the following: (i) First Nations, Métis or Inuit *communities* (ii) First Nations, Métis or Inuit *people* (iii) Indigenous (or Aboriginal) *people or communities* *Note: Identification will occur when using:* • Registries (e.g. Indian Registry System, Métis Citizenship Registry) • Geographic identifiers (e.g. on-reserve postal codes or residence codes used to identify First Nations communities) • Indigenous-specific datasets (e.g. survey or health service delivery data) • Any other variable or level of variable that denotes Indigenous identity (e.g. self-identifiers in survey data)	No - Go directly to Section F

Which Indigenous population(s) will the Project identify? *(Select all that apply)*	Population		Permission:	
	First Nations	☐	Chiefs of Ontario	*Select*
		☐	Grand Council Treaty #3	*Select*
		☐	Kenora Chiefs Advisory	*Select*
	Metis	☐	Métis Nation of Ontario	*Select*
	Inuit	☐	Tungasuvvingat Inuit	*Select*
	Other Indigenous organization or community	☐	Please specify:	*Select*
Your response to the following questions will help reviewers determine the extent to which the necessary approvals have been obtained for use of Indigenous data and/or Indigenous identifiers.	Does the Project intend to use geographic codes to identify First Nations on- and/or off- reserve?			*Select*
	Does the Project intend to identify Indigenous (Aboriginal) people through self-identification (i.e. through specific survey questions)?			*Select*
	If Yes, describe the self-identification variable(s) that will be used and the source:			
	Will the Project identify specific communities (through naming or use of geographic codes)?			*Select*
	If Yes, provide community name(s):			
	How will data *and/or* results of this study be shared with *and/or* communicated to the applicable First Nations, Métis or Inuit organizations *and/or* communities?			

F. CHANGES TO SPECIAL HANDLING

Use this Section to declare any requirement to deviate from ICES policies and procedures or IT specifications in the collection or handling of data for the Project. An example would be a request to use a third party application for primary data collection. Any deviation is subject to a separate Privacy Impact Assessment and approval by ICES' Privacy and Compliance Office.

G. CHANGES TO AFFILIATION & RESPONSIBILITY

ICES research program		**ICES site**	
DAS project type	*Select*		
Principal Investigator			
PI type	☐ Full Status ICES Scientist ☐ ICES Collaborating Researcher	☐ Probationary ICES Scientist ☐ ICES Student / Fellow / Post-doctoral Trainee	
Responsible ICES Scientist (Required if the PI is not a Full Status ICES Scientist)	☐ N/A		

H. CHANGES TO RESEARCH ETHICS BOARD REVIEW & APPROVALS

Use this Section to identify all Research Ethics Board applications and approvals associated with the Project and attachments. Attach copies of approvals and applications, including any accompanying protocols and applicable amendments. Failure to obtain or supply evidence of Research Ethics Board approvals, where required to authorize collection of new data or linking with ICES Data, will delay approval. ICES is not responsible for renewal of, or compliance with, Research Ethics Board approvals obtained by the Principal Investigator or other members of the Project Team.

Research Ethics Board name	Application	Approval
1.	*Select*	*Select*
2.	*Select*	*Select*
3.	*Select*	*Select*
4.	*Select*	*Select*
5.	*Select*	*Select*

ICES Privacy Officer use only	
Shortest REB Approved Retention Period (insert date):	

I. ADDITIONS TO ASSOCIATED AGREEMENTS

Use this Section to identify all agreements associated with the Project such as contracts or SOWs.

Agreement name	Agreement
1.	*Select*
2.	*Select*

J. AMENDMENT ACKNOWLEDGEMENTS & APPROVALS

This Section should be completed, in the order shown, after review of Sections A through G and Schedules 1 and 2. Completion of this Section must not be delegated. Names and dates must be recorded by the individuals identified, and will signify their confirmation or approval, as applicable. The exception is Program Leader approval, which may be recorded by the Program Co-ordinator. This Form is ready for review and approval only when accompanied by all attachments, including signed NDAs for any ICES Collaborating Researchers. Any scientific reservations must be resolved, and the Form updated, before forwarding to ICES' Privacy and Compliance Office by the Program Co-ordinator. (Where there is no Program Co-ordinator, the Program Administrator assumes the role of the Program Co-ordinator.)

Principal Investigator Confirmation

Name	Heather Baltzer	**Date**	February 26, 2018

I request approval to conduct or amend the Project as described on this Form and its Schedules. I warrant that all of the ICES Data identified Schedule 1, including any Project-Specific Data, is reasonably relevant and required to achieve the Project Objectives, and that these cannot be accomplished with other information. I acknowledge that conduct of the Project will be subject to ICES policies and procedures and the conditions identified on this Form and its Schedules, and ICES compliance monitoring.

Responsible ICES Scientist Confirmation *(Only applicable where the Principal Investigator is not a Full Status ICES Scientist.)*

Name	Murray Krahn	**Date**	February 26, 2018

I accept responsibility for overseeing conduct of the Project.

Program Approval *(Where the PI is a Program Leader, the Chief Science Officer or Science Advisor approves. Where the PI is a DAS Staff Scientist, the Science Advisor approves unless AHRQ funding is requested, in which case a Program Leader from the AHRQ Review Team approves.)*

Name	Michael Paterson	**Date**	March 5, 2018
PC (if completed by PC)			

I have reviewed the contents of this Form and its Schedules. I confirm that I approve the project and/or amendments, as described, and am satisfied the data in Schedule 1 is relevant and required to meet the Project Objectives outlined on this Form and all previously approved Forms for the Project.

ICES Privacy & Compliance Office Review & Approval

Compliance & Contracts Officer		**Date**	

I have reviewed and confirm the completeness of Part B of Schedule 1. (As applicable)

Privacy Approval

Privacy Approver	Don DeBoer	**Date**	March 13, 2018

I have reviewed the contents of this Form and the confirmations and approvals in this Section, and approve conduct of the Project, subject to ICES policies and procedures and the terms and conditions identified on this Form including any noted here.

Notes	

J. ACKNOWLEDGEMENT

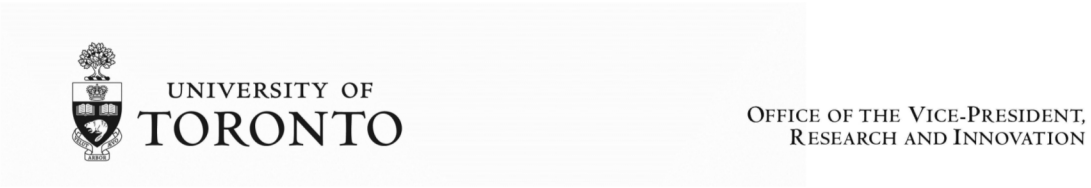
This Section may be completed by any member of the Project Team. The exception is ICES Collaborating Researchers, who are not authorized to complete this Section. It should be completed only by the individual whose name is recorded below, and only after review of all completed Sections. The amendment is effective automatically upon submission to the Privacy and Compliance Office.

Confirmation

Name		Date	

I am a member of the Project Team, and confirm that this Form and its Schedules accurately describe the changes to the Project.

Appendix 2.7: TAHSN REB Approval Letter



Appendix 3.1: Univariate comparisons within hand trauma cohort by sex.

VARIABLE	VALUE	F	M	Mean Standaradized Differenc	P-VALUE
		N=764,605	N=1,281,345		
Age	Mean ± SD	40.87 ± 13.59	37.69 ± 13.19	0.24	<.001
	Median (IQR)	41 (28-53)	36 (26-48)	0.23	<.001
Age Category					
1 (18-30)	1	206,962 (27.1%)	448,649 (35.0%)	0.17	
2 (31-40)	1	148,860 (19.5%)	277,950 (21.7%)	0.06	
3 (41-50)	1	163,880 (21.4%)	260,826 (20.4%)	0.03	
4 (51-65)	1	244,903 (32.0%)	293,920 (22.9%)	0.2	
MHA Service 1 year Pre-Index	0	556,541 (72.8%)	1,063,935 (83.0%)	0.25	
	1	208,064	217,410	0.25	<.001

		(27.2%)	(17.0%)		
ONMARG Summary Score	Mean ± SD	3.06 ± 0.76	3.03 ± 0.75	0.04	<.001
	Median (IQR)	3 (3-4)	3 (3-4)	0.04	<.001
RIO2008 Group	Major Urban	472,798 (61.8%)	782,346 (61.1%)	0.02	<.001
	Missing	11,116 (1.5%)	19,155 (1.5%)	0	
	Rural	91,195 (11.9%)	155,795 (12.2%)	0.01	
	Urban	189,496 (24.8%)	324,049 (25.3%)	0.01	
Income Quintile					
1		167,106 (21.9%)	277,803 (21.7%)	0	0.003
2		155,066 (20.3%)	266,230 (20.8%)	0.01	<.001
3		148,641 (19.4%)	256,229 (20.0%)	0.01	<.001
4		149,917 (19.6%)	253,097 (19.8%)	0	0.011

5		139,437 (18.2%)	220,186 (17.2%)	0.03	<.001
Pre-morbid MHA Issue	0	556,541 (72.8%)	1,063,935 (83.0%)	0.25	
	1	208,064 (27.2%)	217,410 (17.0%)	0.25	<.001
Mechanism					
Laceration	1	215,233 (28.1%)	464,701 (36.3%)	0.17	<.001
Fall	1	197,225 (25.8%)	159,394 (12.4%)	0.34	<.001
Gunshot	1	75 (0.0%)	943 (0.1%)	0.03	<.001
Machinery	1	7,392 (1.0%)	53,739 (4.2%)	0.2	<.001
Cycling	1	8,675 (1.1%)	19,007 (1.5%)	0.03	<.001
Pedestrian	1	1,248 (0.2%)	1,389 (0.1%)	0.01	<.001
Blunt Trauma	1	74,197 (9.7%)	188,677 (14.7%)	0.15	<.001

Injury Type					
Amputation	1	5,526 (0.7%)	21,561 (1.7%)	0.09	<.001
Burn	1	31,325 (4.1%)	30,507 (2.4%)	0.1	<.001
Crush	1	5,954 (0.8%)	17,216 (1.3%)	0.06	<.001
Dislocation	1	10,070 (1.3%)	19,810 (1.5%)	0.02	<.001
Fracture	1	173,832 (22.7%)	242,005 (18.9%)	0.09	<.001
Ligament	1	59,766 (7.8%)	62,125 (4.8%)	0.12	<.001
Nerve	1	1,932 (0.3%)	3,522 (0.3%)	0	0.003
Tendon	1	8,307 (1.1%)	22,970 (1.8%)	0.06	<.001
Vascular	1	329 (0.0%)	932 (0.1%)	0.01	<.001
Other MSK	1	74,044 (9.7%)	97,967 (7.6%)	0.07	<.001
Unspeicified Injury	1	11,742 (1.5%)	13,501 (1.1%)	0.04	<.001

Type					
Wound	1	381,762 (49.9%)	749,173 (58.5%)	0.17	<.001
Surgical	1	18,180 (2.4%)	35,209 (2.7%)	0.02	<.001
Repeated Episode	1	160,216 (21.0%)	347,131 (27.1%)	0.14	<.001
Urgent CTAS Score	1	219,021 (28.6%)	362,897 (28.3%)	0.01	<.001
Workplace	1	35,751 (4.7%)	95,760 (7.5%)	0.12	<.001
		16 (0.0%)	56 (0.0%)	0	
Injury Level	Arm	217 (0.0%)	309 (0.0%)	0	<.001
	Elbow	14,232 (1.9%)	26,366 (2.1%)	0.01	
	Finger	272,493 (35.6%)	560,412 (43.7%)	0.17	
	Forearm	63,075 (8.2%)	95,263 (7.4%)	0.03	
	Hand/Wrist	393,539 (51.5%)	574,515 (44.8%)	0.13	
	Multiple levels	2,300 (0.3%)	5,010 (0.4%)	0.02	

	Shoulder	8,633 (1.1%)	8,244 (0.6%)	0.05	
	Unspecified	10,100 (1.3%)	11,170 (0.9%)	0.04	

Appendix 3.2: Stratification fo Hand Trauma Episodes by Mental Health and Addiction Service (MHA) Utilization in the year prior to hand trauma episode.

VARIABLE	VALUE	No Pre-Morbid MHA Issue	Pre-Morbid MHA Issue	STANDARDIZED DIFFERENCE	P-VALUE
		N=1,620,476	N=425,474		
Sex	F	556,541 (34.3%)	208,064 (48.9%)	0.3	<.001
	M	1,063,935 (65.7%)	217,410 (51.1%)	0.3	
Age	Mean ± SD	38.75 ± 13.51	39.38 ± 13.11	0.05	<.001
	Median (IQR)	38 (26-50)	39 (28-50)	0.05	<.001
Age Category					
1 (18-30)	1	531,230 (32.8%)	124,381 (29.2%)	0.08	<.001
2 (31-40)	1	333,587 (20.6%)	93,223 (21.9%)	0.03	<.001
3 (41-50)	1	330,050 (20.4%)	94,656 (22.2%)	0.05	<.001

4 (51-65)	1	425,609 (26.3%)	113,214 (26.6%)	0.01	<.001
ONMARG Summary Score	Mean ± SD	3.01 ± 0.75	3.14 ± 0.76	0.16	<.001
	Median (IQR)	3 (3-4)	3 (3-4)	0.16	<.001
RIO2008 Group	Major Urban	981,324 (60.6%)	273,820 (64.4%)	0.08	<.001
	Missing	24,506 (1.5%)	5,765 (1.4%)	0.01	
	Rural	203,113 (12.5%)	43,877 (10.3%)	0.07	
	Urban	411,533 (25.4%)	102,012 (24.0%)	0.03	
Income Quintile					
1		336,144 (20.7%)	108,765 (25.6%)	0.11	<.001
2		332,924 (20.5%)	88,372 (20.8%)	0.01	0.001
3		324,587 (20.0%)	80,283 (18.9%)	0.03	<.001

4		326,294 (20.1%)	76,720 (18.0%)	0.05	<.001
5		291,101 (18.0%)	68,522 (16.1%)	0.05	<.001
Mechanism					
Laceration	1	548,552 (33.9%)	131,382 (30.9%)	0.06	<.001
Fall	1	272,606 (16.8%)	84,013 (19.7%)	0.08	<.001
Gunshot	1	790 (0.0%)	228 (0.1%)	0	0.208
Machinery	1	52,414 (3.2%)	8,717 (2.0%)	0.07	<.001
Cycling	1	21,217 (1.3%)	6,465 (1.5%)	0.02	<.001
Pedestrian	1	1,884 (0.1%)	753 (0.2%)	0.02	<.001
Blunt Trauma	1	206,198 (12.7%)	56,676 (13.3%)	0.02	<.001

Injury Type					
Amputation	1	23,038 (1.4%)	4,049 (1.0%)	0.04	<.001
Burn	1	47,618 (2.9%)	14,214 (3.3%)	0.02	<.001
Crush	1	19,264 (1.2%)	3,906 (0.9%)	0.03	<.001
Dislocation	1	24,289 (1.5%)	5,591 (1.3%)	0.02	<.001
Fracture	1	327,547 (20.2%)	88,290 (20.8%)	0.01	<.001
Ligament	1	95,573 (5.9%)	26,318 (6.2%)	0.01	<.001
Nerve	1	4,135 (0.3%)	1,319 (0.3%)	0.01	<.001
Tendon	1	25,262 (1.6%)	6,015 (1.4%)	0.01	<.001
Vascular	1	959 (0.1%)	302 (0.1%)	0	0.006

Other MSK	1	130,130 (8.0%)	41,881 (9.8%)	0.06	<.001
Unspeicified Injury Type	1	19,045 (1.2%)	6,198 (1.5%)	0.02	<.001
Wound	1	903,559 (55.8%)	227,376 (53.4%)	0.05	<.001
Repeated Episode	1	378,622 (23.4%)	128,725 (30.3%)	0.16	<.001
Surgical	1	42,415 (2.6%)	10,974 (2.6%)	0	0.164
Urgent CTAS Score	1	449,607 (27.7%)	132,311 (31.1%)	0.07	<.001
Workplace Injury	1	110,640 (6.8%)	20,871 (4.9%)	0.08	<.001
		57 (0.0%)	15 (0.0%)	0	
Injury Level	Arm	411 (0.0%)	115 (0.0%)	0	<.001
	Elbow	32,228 (2.0%)	8,370 (2.0%)	0	
	Finger	680,531 (42.0%)	152,374 (35.8%)	0.13	

	Forearm	120,706 (7.4%)	37,632 (8.8%)	0.05	
	Hand/Wrist	752,157 (46.4%)	215,897 (50.7%)	0.09	
	Multiple levels	6,142 (0.4%)	1,168 (0.3%)	0.02	
	Shoulder	12,902 (0.8%)	3,975 (0.9%)	0.01	
	Unspecified	15,342 (0.9%)	5,928 (1.4%)	0.04	

Appendix 3.3: Stratified analysis of hand trauma cohort based on repeated episode

VARIABLE	VALUE	Single Hand Trauma Event	Repeated Hand Trauma Events	STANDARDIZED DIFFERENCE	P-VALUE
		N=1,538,603	N=507,347		
Sex	F	604,389 (39.3%)	160,216 (31.6%)	0.16	<.001
	M	934,214 (60.7%)	347,131 (68.4%)	0.16	
Age	Mean ± SD	39.14 ± 13.60	38.09 ± 12.85	0.08	<.001
	Median (IQR)	39 (27-51)	36 (27-49)	0.07	<.001
Age Category					
1 (18-30)		485,394 (31.5%)	170,217 (33.6%)	0.04	<.001
2 (31-40)		308,476 (20.0%)	118,334 (23.3%)	0.08	<.001
3 (41-50)		324,363 (21.1%)	100,343 (19.8%)	0.03	<.001
4 (51-65)		420,370 (27.3%)	118,453 (23.3%)	0.09	<.001

MHA Service 1 year Pre-Index	0	1,241,854 (80.7%)	378,622 (74.6%)	0.15	
	1	296,749 (19.3%)	128,725 (25.4%)	0.15	<.001
ONMARG Summary Score	Mean ± SD	3.03 ± 0.76	3.07 ± 0.74	0.05	
	Median (IQR)	3 (3-4)	3 (3-4)	0.05	<.001
					<.001
RIO2008 Group	Major Urban	976,171 (63.4%)	278,973 (55.0%)	0.17	
	Missing	21,228 (1.4%)	9,043 (1.8%)	0.03	<.001
	Rural	170,686 (11.1%)	76,304 (15.0%)	0.12	
	Urban	370,518 (24.1%)	143,027 (28.2%)	0.09	
Income Quintile					
1	1	321,138 (20.9%)	123,771 (24.4%)	0.08	<.001
2	1	313,516 (20.4%)	107,780 (21.2%)	0.02	<.001
3	1	305,600 (19.9%)	99,270 (19.6%)	0.01	<.001

4	1	308,947 (20.1%)	94,067 (18.5%)	0.04	<.001
5	1	280,611 (18.2%)	79,012 (15.6%)	0.07	<.001
Mechanism					
Laceration	1	528,172 (34.3%)	151,762 (29.9%)	0.09	<.001
Fall	1	271,487 (17.6%)	85,132 (16.8%)	0.02	<.001
Gunshot	1	707 (0.0%)	311 (0.1%)	0.01	<.001
Machinery	1	46,156 (3.0%)	14,975 (3.0%)	0	0.08
Cycling	1	21,353 (1.4%)	6,329 (1.2%)	0.01	<.001
Pedestrian	1	2,060 (0.1%)	577 (0.1%)	0.01	<.001
Blunt Trauma	1	187,490 (12.2%)	75,384 (14.9%)	0.08	<.001
Injury Type					

Amputation	1	20,829 (1.4%)	6,258 (1.2%)	0.01	<.001
Burn	1	46,910 (3.0%)	14,922 (2.9%)	0.01	<.001
Crush	1	16,937 (1.1%)	6,233 (1.2%)	0.01	<.001
Dislocation	1	23,512 (1.5%)	6,368 (1.3%)	0.02	<.001
Fracture	1	306,742 (19.9%)	109,095 (21.5%)	0.04	<.001
Ligament	1	87,773 (5.7%)	34,118 (6.7%)	0.04	<.001
Nerve	1	3,637 (0.2%)	1,817 (0.4%)	0.02	<.001
Tendon	1	21,739 (1.4%)	9,538 (1.9%)	0.04	<.001
Vascular	1	912 (0.1%)	349 (0.1%)	0	0.018
Other MSC	1	123,175 (8.0%)	48,836 (9.6%)	0.06	<.001
Unspeicified Injury Type	1	18,936 (1.2%)	6,307 (1.2%)	0	0.488

Wound	1	867,450 (56.4%)	263,485 (51.9%)	0.09	<.001
Surgical Hand Trauma	1	37,630 (2.4%)	15,759 (3.1%)	0.04	<.001
Urgent CTAS Score	1	435,391 (28.3%)	146,527 (28.9%)	0.01	<.001
Workplace Injury	1	98,300 (6.4%)	33,211 (6.5%)	0.01	<.001
		51 (0.0%)	21 (0.0%)	0	
Injury Level	Arm	395 (0.0%)	131 (0.0%)	0	<.001
	Elbow	30,818 (2.0%)	9,780 (1.9%)	0.01	
	Finger	643,282 (41.8%)	189,623 (37.4%)	0.09	
	Forearm	117,787 (7.7%)	40,551 (8.0%)	0.01	
	Hand/Wrist	711,714 (46.3%)	256,340 (50.5%)	0.09	
	Multiple levels	5,736 (0.4%)	1,574 (0.3%)	0.01	
	Shoulder	12,593 (0.8%)	4,284 (0.8%)	0	
	Unspecified	16,227 (1.1%)	5,043 (1.0%)	0.01	

Appendix 3.4: Stratified analysis of hand trauma cohort by surgical and non-surgical treatment

VARIABLE	VALUE	Non-surgical	Surgical	STANDARDIZED DIFFERENCE	P-VALUE
		N=1,992,561	N=53,389		
Sex	F	746,425 (37.5%)	18,180 (34.1%)	0.07	<.001
	M	1,246,136 (62.5%)	35,209 (65.9%)	0.07	
Age	Mean ± SD	38.81 ± 13.41	41.32 ± 13.64	0.19	<.001
	Median (IQR)	38 (27-50)	42 (29-53)	0.18	<.001
Age Category					
1		641,667 (32.2%)	13,944 (26.1%)	0.13	<.001
2		416,770 (20.9%)	10,040 (18.8%)	0.05	<.001
3		413,019 (20.7%)	11,687 (21.9%)	0.03	<.001
4		521,105	17,718	0.15	<.001

		(26.2%)	(33.2%)		
MHA Service 1 year Pre-Index	1	414,500 (20.8%)	10,974 (20.6%)	0.01	
ONMARG Summary Score	Mean ± SD	3.04 ± 0.75	3.03 ± 0.75	0.02	<.001
	Median (IQR)	3 (3-4)	3 (3-4)	0.02	<.001
RIO2008 Group	Major Urban	1,221,876 (61.3%)	33,268 (62.3%)	0.02	<.001
	Missing	29,320 (1.5%)	951 (1.8%)	0.02	
	Rural	240,878 (12.1%)	6,112 (11.4%)	0.02	
	Urban	500,487 (25.1%)	13,058 (24.5%)	0.02	
Income Quintile					
1	1	433,446 (21.8%)	11,463 (21.5%)	0.01	0.118
2	1	410,584 (20.6%)	10,712 (20.1%)	0.01	0.002

3	1	394,388 (19.8%)	10,482 (19.6%)	0	0.361
4	1	392,613 (19.7%)	10,401 (19.5%)	0.01	0.202
5	1	349,659 (17.5%)	9,964 (18.7%)	0.03	<.001
Mechanism					
Laceration	1	665,339 (33.4%)	14,595 (27.3%)	0.13	<.001
Fall	1	341,043 (17.1%)	15,576 (29.2%)	0.29	<.001
Gunshot	1	870 (0.0%)	148 (0.3%)	0.06	<.001
Machinery	1	57,414 (2.9%)	3,717 (7.0%)	0.19	<.001
Cycling	1	26,349 (1.3%)	1,333 (2.5%)	0.09	<.001
Pedestrian	1	2,516 (0.1%)	121 (0.2%)	0.02	<.001
Blunt Trauma	1	257,324	5,550	0.08	<.001

		(12.9%)	(10.4%)		
Injury Type					
Amputation	1	24,694 (1.2%)	2,393 (4.5%)	0.2	<.001
Burn	1	61,422 (3.1%)	410 (0.8%)	0.17	<.001
Crush	1	22,770 (1.1%)	400 (0.7%)	0.04	<.001
Dislocation	1	28,913 (1.5%)	967 (1.8%)	0.03	<.001
Fracture	1	388,100 (19.5%)	27,737 (52.0%)	0.72	<.001
Ligament	1	121,303 (6.1%)	588 (1.1%)	0.27	<.001
Nerve	1	4,418 (0.2%)	1,036 (1.9%)	0.17	<.001
Tendon	1	25,477 (1.3%)	5,800 (10.9%)	0.41	<.001
Vascular	1	903 (0.0%)	358 (0.7%)	0.1	<.001

Other MSC	1	170,651 (8.6%)	1,360 (2.5%)	0.26	<.001
Unspeicified Injury Type	1	25,056 (1.3%)	187 (0.4%)	0.1	<.001
Wound	1	1,118,805 (56.1%)	12,130 (22.7%)	0.73	<.001
Repeated Episode	1	491,588 (24.7%)	15,759 (29.5%)	0.11	<.001
Urgent CTAS Score	1	548,864 (27.5%)	33,054 (61.9%)	0.74	<.001
Workplace Injury	1	128,726 (6.5%)	2,785 (5.2%)	0.05	<.001
Injury Level	Arm	49 (0.0%)	23 (0.0%)	0.03	
	Elbow	494 (0.0%)	32 (0.1%)	0.02	<.001
	Finger	39,701 (2.0%)	897 (1.7%)	0.02	
	Forearm	815,304 (40.9%)	17,601 (33.0%)	0.17	
	Hand/Wrist	150,232 (7.5%)	8,106 (15.2%)	0.24	

	Multilevel	941,751 (47.3%)	26,303 (49.3%)	0.04	
	Shoulder	7,246 (0.4%)	64 (0.1%)	0.05	
	Unspecified	16,726 (0.8%)	151 (0.3%)	0.07	
		21,058 (1.1%)	212 (0.4%)	0.08	

Appendix 4.1: Surgical Hand Trauma Matched Cohort Baseline Characteristics (Index dates between April 1, 2006 – March 31, 2014).

VARIABLE	VALUE	Controls	Cases	STANDARDIZED DIFFERENCE	P-VALUE
		N=104,353	N=26,123		
Male		67,095 (64.3%)	16,799 (64.3%)	0	0.973
Mental Health Utilization in Year Prior to Index		19,126 (18.3%)	4,803 (18.4%)	0	0.829
Age	Mean ± SD	41.83 ± 13.62	41.83 ± 13.62	0	0.981
	Median (IQR)	43 (30-53)	43 (30-53)	0	0.98
Age Group	17-19	4,700 (4.5%)	1,176 (4.5%)	0	1
	20-24	10,876 (10.4%)	2,720 (10.4%)	0	
	25-29	9,648 (9.2%)	2,419 (9.3%)	0	
	30-34	9,263 (8.9%)	2,321 (8.9%)	0	

	35-39	9,611 (9.2%)	2,408 (9.2%)	0	
	40-44	11,691 (11.2%)	2,928 (11.2%)	0	
	45-49	12,981 (12.4%)	3,246 (12.4%)	0	
	50-54	12,571 (12.0%)	3,145 (12.0%)	0	
	55-59	11,859 (11.4%)	2,968 (11.4%)	0	
	60-66	11,153 (10.7%)	2,792 (10.7%)	0	
Income Quintile	1	21,537 (20.6%)	5,316 (20.3%)	0.01	0.839
	2	20,990 (20.1%)	5,252 (20.1%)	0	
	3	21,079 (20.2%)	5,247 (20.1%)	0	
	4	20,494 (19.6%)	5,180 (19.8%)	0	
	5	19,674 (18.9%)	4,987 (19.1%)	0.01	
	9	579 (0.6%)	141 (0.5%)	0	
ACG Group	0-5	88,449 (84.8%)	22,064 (84.5%)	0.01	0.24
	6-9	13,646 (13.1%)	3,453 (13.2%)	0	
	10+	2,258	606 (2.3%)	0.01	

		(2.2%)			
LHIN	1	5,630 (5.4%)	1,383 (5.3%)	0	0.411
	2	10,091 (9.7%)	2,445 (9.4%)	0.01	
	3	5,449 (5.2%)	1,393 (5.3%)	0	
	4	12,741 (12.2%)	3,130 (12.0%)	0.01	
	5	5,948 (5.7%)	1,470 (5.6%)	0	
	6	7,372 (7.1%)	1,851 (7.1%)	0	
	7	8,992 (8.6%)	2,168 (8.3%)	0.01	
	8	9,488 (9.1%)	2,453 (9.4%)	0.01	
	9	12,536 (12.0%)	3,116 (11.9%)	0	
	10	4,956 (4.7%)	1,268 (4.9%)	0	
	11	7,605 (7.3%)	1,975 (7.6%)	0.01	
	12	4,041 (3.9%)	1,042 (4.0%)	0.01	
	13	6,836 (6.6%)	1,773 (6.8%)	0.01	
	14	2,630 (2.5%)	644 (2.5%)	0	

	99	38 (0.0%)	12 (0.0%)	0	
RIO2008 Group	Major Urban	69,160 (66.3%)	17,099 (65.5%)	0.02	0.033
	Missing	1,445 (1.4%)	396 (1.5%)	0.01	
	Rural	9,797 (9.4%)	2,552 (9.8%)	0.01	
	Urban	23,951 (23.0%)	6,076 (23.3%)	0.01	
ONMARG Summary Score	2	7,349 (7.0%)	1,824 (7.0%)	0	0.043
	3	11,991 (11.5%)	2,945 (11.3%)	0.01	
	4	7,784 (7.5%)	1,935 (7.4%)	0	
	5	316 (0.3%)	82 (0.3%)	0	
	9	1,265 (1.2%)	339 (1.3%)	0.01	
	1.5	1,470 (1.4%)	404 (1.5%)	0.01	
	2.5	10,968 (10.5%)	2,675 (10.2%)	0.01	
	3.5	9,885 (9.5%)	2,456 (9.4%)	0	
	4.5	2,349 (2.3%)	619 (2.4%)	0.01	
	1.25	130 (0.1%)	34 (0.1%)	0	

	1.75	4,253 (4.1%)	1,083 (4.1%)	0	
	2.25	9,856 (9.4%)	2,441 (9.3%)	0	
	2.75	12,241 (11.7%)	3,207 (12.3%)	0.02	
	3.25	10,226 (9.8%)	2,680 (10.3%)	0.02	
	3.75	8,852 (8.5%)	2,065 (7.9%)	0.02	
	4.25	4,387 (4.2%)	1,080 (4.1%)	0	
	4.75	1,031 (1.0%)	254 (1.0%)	0	

Appendix 4.2: Stratified analysis of attributable healthcare costs following hand trauma by sex.

VARIABLE	VALUE	Female	Male	TOTAL	P-VALUE
		N=9,324	N=16,799	N=26,123	
Attributable Cost					
30 Day	Mean ± SD	5,538.96 ± 4,337.85	5,780.82 ± 5,606.13	5,694.49 ± 5,190.35	<.001
1 Year	Mean ± SD	7,496.56 ± 12,038.96	7,532.66 ± 13,587.24	7,519.77 ± 13,055.49	0.83
2 Year	Mean ± SD	8,114.58 ± 17,681.07	7,964.57 ± 18,913.77	8,018.11 ± 18,483.02	0.53
3 Year	Mean ± SD	8,728.94 ± 25,355.03	8,417.80 ± 25,850.38	8,528.85 ± 25,674.62	0.348

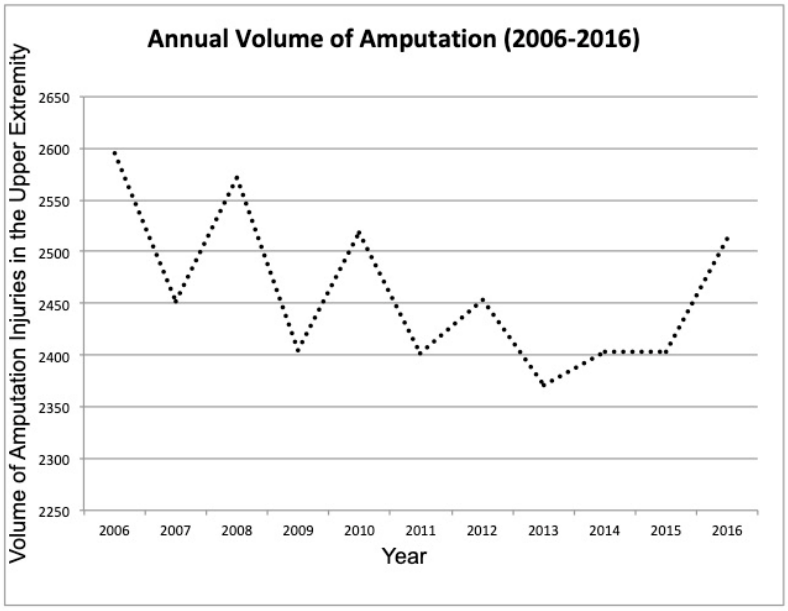
Appendix 4.3: Stratified analysis of attributable healthcare costs following hand trauma by pre-morbid mental health and addiction (MHA) service access (1 year pre-index).

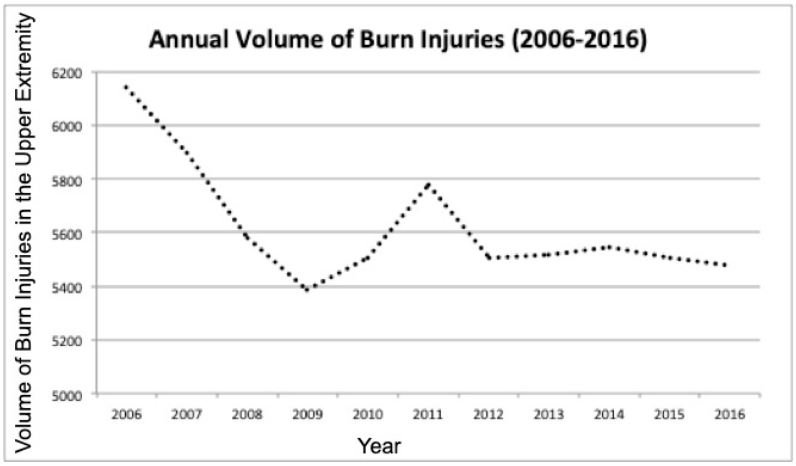
VARIABLE	VALUE	No Pre-Morbid MHA Issue	Pre-Morbid MHA Issue	TOTAL	P-VALUE
		N=21,320	N=4,803	N=26,123	
Attributable Costs					
30 day	Mean ± SD	5,646.00 ± 5,078.72	5,909.73 ± 5,654.92	5,694.49 ± 5,190.35	0.001
1 year	Mean ± SD	7,345.37 ± 12,002.32	8,293.95 ± 16,938.37	7,519.77 ± 13,055.49	<.001
2 year	Mean ± SD	7,870.05 ± 16,215.15	8,675.33 ± 26,277.77	8,018.11 ± 18,483.02	0.006
3 year	Mean ± SD	8,293.38 ± 21,046.29	9,574.09 ± 40,224.41	8,528.85 ± 25,674.62	0.002

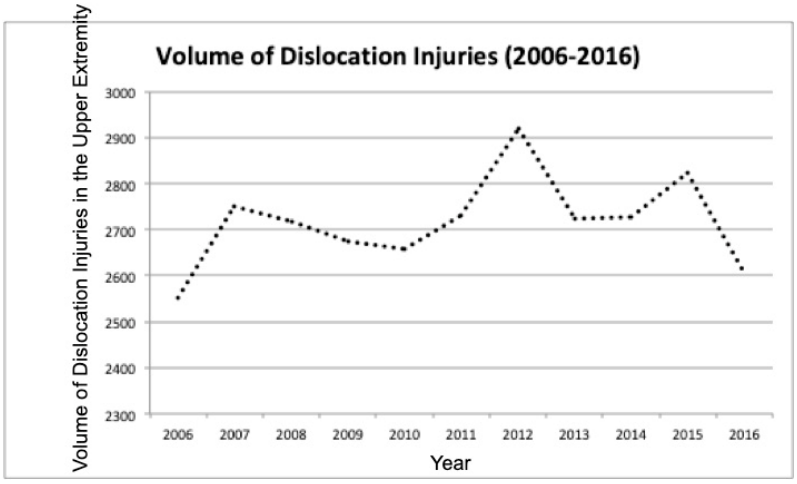
Appendix 4.4: Stratified analysis of attributable healthcare costs within three years between patients that utilized mental health and addiction services (MHA) post-index hand trauma

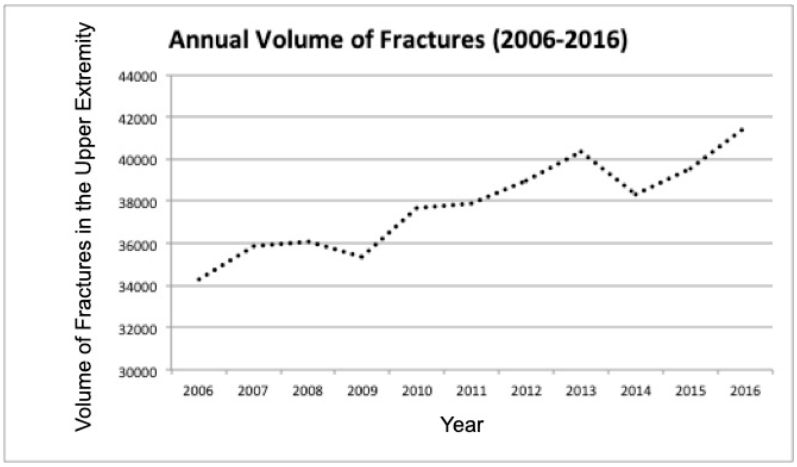
VARIABLE	VALUE	No MHA Issue Post-Index	MHA Issue Post-Index	TOTAL	P-VALUE
		N=17,296	N=8,827	N=26,123	
Attributable Costs					
30 Day	Mean ± SD	5,489.54 ± 4,732.26	6,096.08 ± 5,967.10	5,694.49 ± 5,190.35	<.001
1 Year	Mean ± SD	6,863.32 ± 11,522.40	8,806.06 ± 15,549.98	7,519.77 ± 13,055.49	<.001
2 Year	Mean ± SD	7,021.99 ± 15,551.23	9,969.97 ± 23,052.83	8,018.11 ± 18,483.02	<.001
3 Year	Mean ± SD	7,084.70 ± 19,802.25	11,358.59 ± 34,212.23	8,528.85 ± 25,674.62	<.001

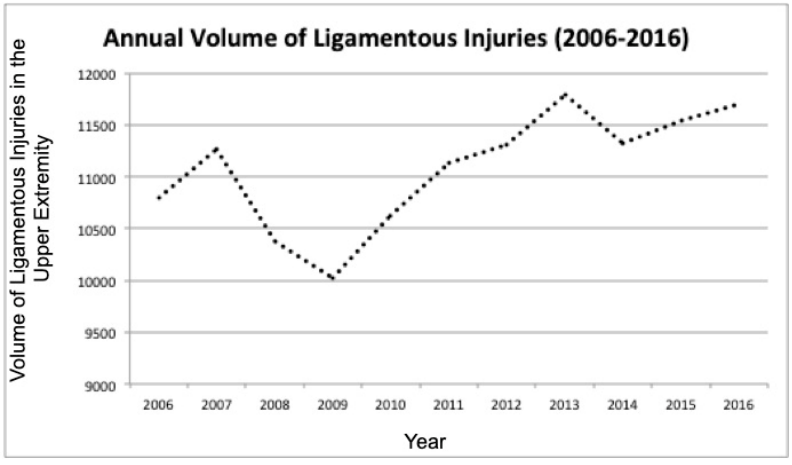
Appendix 5.1: Annual Trends in Volume of Hand, Wrist and Specific Upper Extremity Injury By Type

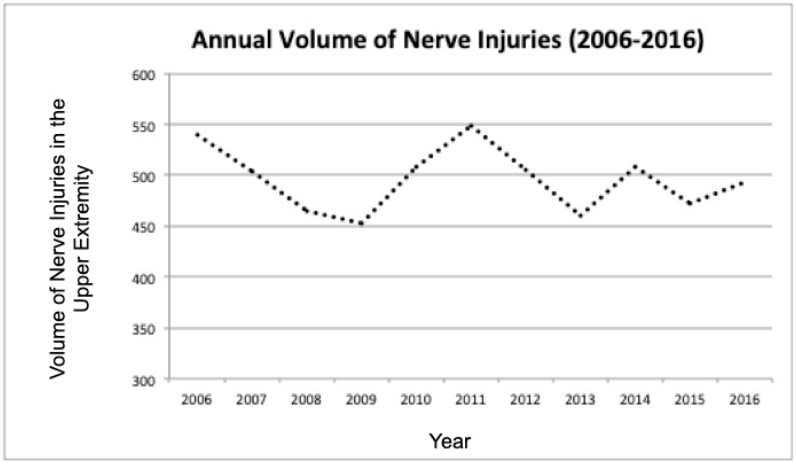


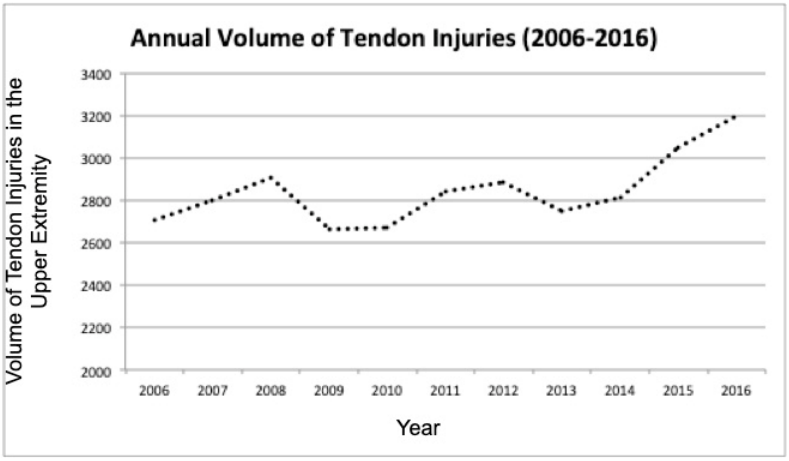


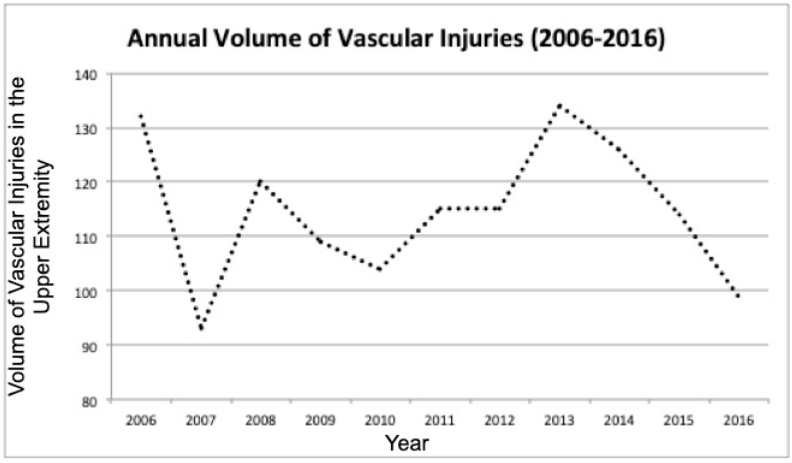

Volume of Dislocation Injuries (2006-2016)
Volume of Dislocation Injuries in the Upper Extremity
3000
2900
2800
2700
2600
2500
2400
2300
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


Annual Volume of Fractures (2006-2016)
Volume of Fractures in the Upper Extremity
44000
42000
40000
38000
36000
34000
32000
30000
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


Annual Volume of Ligamentous Injuries (2006-2016)
Volume of Ligamentous Injuries in the Upper Extremity
12000
11500
11000
10500
10000
9500
9000
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


Annual Volume of Nerve Injuries (2006-2016)
Volume of Nerve Injuries in the Upper Extremity
600
550
500
450
400
350
300
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


Annual Volume of Tendon Injuries (2006-2016)
Volume of Tendon Injuries in the Upper Extremity
3400
3200
3000
2800
2600
2400
2200
2000
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


Annual Volume of Vascular Injuries (2006-2016)
Volume of Vascular Injuries in the Upper Extremity
140
130
120
110
100
90
80
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year

Appendix 5.2: Temporal trends in Ontario adult population by sex and age category. [2]