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Concordance between childhood injury diagnoses from an injury surveillance system and a physician billing claims database

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RÉSUMÉ

Les estimations de l'impact de blessures sur une société diffèrent selon la manière dont l'information concernant ces blessures est obtenue. Un système de surveillance des blessures contient une richesse de renseignements relativement au contexte particulier entourant ces blessures. Par contre, puisqu'une telle base de données ne contient généralement pas les renseignements englobant toute la population, elle ne peut être utilisée pour évaluer l'incidence des blessures (66). Une alternative à cette base de données est celle pour les remboursements des médecins, car il est plus probable qu'elle ait une couverture complète des blessures nécessitant des soins médicaux. Il se peut que cette base de données soit particulièrement utile pour la surveillance des blessures. Au Québec, la base de données des remboursements des médecins pourrait fournir de l'information sur l'incidence de blessures chez les enfants.

Objectifs: 1) déterminer la concordance entre les codes diagnostics des blessures [traumatisme crânien (TC), TC probable ou une blessure musculosquelettique (MSQ)] chez des enfants qui ont reçu des soins à l'urgence pour une blessure et ce, en utilisant deux sources de données: un système de surveillance des blessures (le Système Canadien Hospitalier d'Information et de Recherche en Prévention des Traumatismes (SCHIRPT)) et la base de données des remboursements des médecins (Régie de l'assurance maladie du Québec (RAMQ)), et 2) déterminer la sensibilité et la spécificité des codes diagnostics et des codes d'actes dans la base de données RAMQ à identifier les blessures TC et MSQ chez les enfants.

Méthodologie: Dans cette étude de cohorte, les données de 3049 enfants qui ont reçu des soins pour une blessure (2000-2001), ont été obtenues à partir de deux sources de données qui étaient liées entre elles en utilisant le numéro d'assurance maladie de l'enfant. Les codes diagnostics de SCHIRPT ont été utilisés pour catégoriser les enfants en trois groupes (TC, TC probable et MSQ), tandis qu'un algorithme, utilisant les codes diagnostics ICD-9-CM et ceux des codes d'actes de la RAMQ, a été développé et utilisé pour classifier les enfants dans les mêmes trois groupes.

Résultats: Le degré de concordance entre les deux sources de données était «substantielle» (Kappa pondéré 0,66; Intervalle de Confiance (CI) 95%: 0,63-0,69). La sensibilité des codes diagnostics et des codes d'actes dans la base de données RAMQ pour identifier un TC et une blessure MSQ était de 0,61 (95% CI: 0,57-0,64) et de 0,97 (95% CI: 0,96-0,98), respectivement. La spécificité à identifier un TC et une blessure MSQ était de 0,97 (95% CI: 0,96-0,98) et de 0,58 (95% CI: 0,56-0,63), respectivement.

Conclusion: La combinaison des codes diagnostics et des codes d'actes dans la base de données RAMQ peut être une méthode valide pour estimer l'incidence de blessure chez des enfants.

Mots clés : système de surveillance, blessure, traumatisme crânien, validité, base de données des remboursements.

ABSTRACT

Estimates of the population burden of injuries differ depending on how information about injury is obtained. An injury surveillance system contains rich contextual information on particular subsets of injuries, but since such a database is generally not population-based, it cannot be used to estimate the incidence of injury (66). Physician claims databases, due to their presumed near complete coverage of injuries requiring medical care may be particularly useful for injury surveillance. In Québec, the physician claims database may provide information on the incidence of injuries among children.

Objectives: 1) to determine the concordance between injury diagnoses (Head injury (HI), Probable HI or Musculoskeletal Injury (MSK)) for children visiting an emergency department (ED) for an injury using two data sources: an injury surveillance system (Canadian Hospitals Injury Research and Prevention Program, (CHIRPP)) and a physician claims database (Régie de l'assurance maladie de Québec, (RAMQ)), and 2) to determine the sensitivity and specificity of diagnostic and procedure codes in physician claims database for identifying HI and MSK injury among children.

Design: In this cross sectional cohort, data for 3049 children who sought care for an injury (2000-2001) were obtained from both sources and linked using the child's personal health insurance number.

Methods: The physician recorded diagnostic codes from CHIRPP were used to categorize the children into three groups (HI, Probable HI and MSK), while an algorithm, using ICD-9-CM diagnostic and procedure codes from the RAMQ, was used to classify children into the same three groups.

Results: Concordance between the data sources was "substantial' (weighted Kappa 0.66; 95% Confidence Interval (CI): 0.63-0.69). The sensitivity of diagnostic and procedure codes in the RAMQ database for identifying HI and for MSK injury were 0.61

(95% CI: 0.57-0.64) and 0.97 (95% CI: 0.96-0.98), respectively. The specificity for identifying HI and for MSK injury were 0.97 (95% CI: 0.96-0.98) and 0.58 (95% CI: 0.56-0.63), respectively

Conclusion: Combining diagnostic and procedures codes in a physician claims database (i.e. the RAMQ database) may be a valid method of estimating injury occurrence among children.

Keywords: Injury surveillance systems, Injury, Head injury, Validity, Physician claims.

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LIST OF ABBREVIATIONS

AIS	Abbreviated Injury Scale
CI	Confidence Interval
CHIRPP	Canadian Hospitals Injury Research and Prevention Program
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ICDMAP	Software that translates ICD-9-CM codes into an Abbreviated Injury Scale
HI	Head Injury
MSK	Musculoskeletal Injury
RAMQ	Régie de l'assurance maladie de Québec or Quebec Health Insurance Agency
SES	Socio-economic status
WHO	World Health Organisation

DEDICATION

À ma famille et à Daria Trojan qui m'ont beaucoup encouragé à suivre mes passions et à relever des défis

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CHAPTER 1: INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

Injury is a major cause of death and disability. Unintentional injury represents the leading cause of death of Canadians between the ages of 1 and 34 years (37) and is responsible for more productive years of life lost than cancer, stroke, and heart disease (9) (15). Although absolute rates of injury have dropped significantly over the past 20 years, in 1997, injuries accounted for 32% of deaths in children aged 1 to 4 years, 41% of those in children aged 5 to 9 years and 52% of those among children 10 to 14 yr (16).

Head injury (HI) in childhood warrants particular attention because of the potential cognitive, physical, behavioral sequelae. It is a leading cause of death (52), and disability (114). Moreover, it can affect the activities of daily life (58), and the risk of readmission to hospital (19). About 18 000 patients are admitted to hospital with brain injuries in Canada annually (1). The published incidence rates of HI in emergency department (ED) settings range from 180 (52) to 444 (41) per 100 000 population, with an overall male bias and a peak incidence in those aged 15–24 years (52).

Information about paediatric injury, including HI in Canada can be gleaned from a number of sources. These include population surveys, medical record reviews, hospital and trauma registries (including physician claims database) and injury surveillance systems. With regards to the latter, the Canadian Hospitals Injury Research and

Prevention Program (CHIRPP) is a primary source of information on patterns of childhood injury in Canada.

Physician claims database may be an alternative database for injury surveillance due to its presumed near complete coverage of injuries requiring medical care and its lack of reliance on self-reports. Moreover, physician claims data also provide an opportunity to examine health care costs associated with injury. But as with CHIRPP they only capture injuries that receive medical care, which tend to over represent more severe injuries.

It is not clear how the injury information provided by physician claims database compares with that obtained from an injury surveillance system. Although physician claims data are not collected for research purposes, but since the Quebec physician claims database is population-based, it potentially may provide adequate information about the epidemiology of injuries, especially, the incidence of HI among children in the province.

1.2 OBJECTIVES AND HYPOTHESES

The main goal of this study was to validate the use of physician claims data as a source of identifying HI and musculoskeletal (MSK) injuries. Specifically, primary objectives were to: 1) determine the concordance between injury diagnoses for HI and MSK injury among children visiting an emergency department (ED) for an injury using two data sources: an injury surveillance system (CHIRPP) and an physician claims database (Régie de l'assurance maladie de Québec, (RAMQ)), and 2) determine the sensitivity and specificity of diagnostic and procedure codes in RAMQ database for HI and MSK injury among children.

We hypothesized that moderate concordance (i.e. Kappa > 0.6) would exist between the two data sources with regard to identifying HI, and that sensitivity and specificity of diagnostic and procedure codes in RAMQ database for HI and MSK injury would be high.

CHAPTER 2: REVIEW OF LITERATURE

2.1 INJURY IN CHILDREN

2.1.1 Definition and epidemiology

Injury is a serious public health issue in Canada and a major cause of long and short-term disability among Canadians. It is the leading cause of death among children and young adults. Injuries are a contributor to potential years of life lost because of their concentrated impact upon young people. Moreover, in Canada, injuries account for 9% of all preschool hospital admissions and are the leading cause of hospitalisation among children 10 to 14 years (16). Each year about 500 000 children aged 18 years and under injure themselves severely enough to require medical attention or to limit their participation in activities (85). In economic terms, in 1998, injury accounted for 8% of the economic burden of illness in Canada (36).

Several risk factors for injury have been identified. Typically, most injured children are males and the highest rates of injury occur among children between the ages of 10-14 years (82). Controversy exists as to whether socio-economic status (SES) influences the risk of injury in children. Several studies found an association between higher SES and injury risk among infants, children and adolescents under 18 years (4) (47) (50) (99). A detailed analysis of data from the National Longitudinal Survey of children and adolescents (ELNEJ, 1994-1995 et 1996-1997) did not show an association between the level of parental education (a proxy measure for SES) and the number of injuries in children (117) nor between family revenue and injury risk (85). With regards to injuries sustained during sports and recreation activities, children from affluent families (higher income, higher level of parental education) were found to be at increased risk of injury due to their increased risk of exposure to 'hazardous' activities (78). Finally, it appears that a child's neighborhood (another indicator of SES) is associated with risk of injury; the poorer the neighborhood, the higher the risk of injury (25) (28) (35) (44) (90).

Before continuing further we should state what we mean by injury. The World Health Organisation (WHO) provides the following definitions regarding injury: "An injury is the physical damage that results when a human body is suddenly or briefly subjected to intolerable levels of energy. It can be a bodily lesion resulting from acute exposure to energy in amounts that exceed the threshold of physiological tolerance, or it can be an impairment of function resulting from a lack of one or more vital elements (i.e. air, water, warmth), as in drowning, strangulation or freezing. The time between exposure to the energy and the appearance of an injury is short (118).

Injuries may be categorised in a number of ways. They are often categorised according to whether or not they were deliberately inflicted and by whom. Unintentional injuries are involuntarily caused by motor vehicle collisions, drowning, falls, burns, poisonings, etc., while intentional injuries are deliberate acts such as child abuse, family violence, suicide, homicide, etc. Injuries can also be of undetermined intent.

Injuries can also be categorised according to the mechanism (or activity), nature of injury (fracture, laceration, etc) or the body part (e.g. head, lower limb) involved. The most common mechanisms of injury in children are due to motor vehicle traffic, falls, child abuse and sports (82), but they vary by age. The Statistical Report on the Health of Canadians in 1998 reported that the most common types of childhood injuries were fractures, open wounds, and superficial injuries (20% for each category). But for fall-related ED visits, the head and neck are injured most often (49%), followed by injuries to the extremities (upper limbs 27%, lower limbs 18%) (37). Another study reported that MSK injury of the upper and lower extremity account for as much as 53% of all visits to the ED of pediatric hospitals in Canada (85).

With regards to nature of injury, in 2004, Norton and colleagues conducted a systematic review of literature on playground injury. Their results suggest that fractures remain among the most commonly reported fall-related injury across the range of reports that date from 1974 to 2001 (79), however, few studies provided detailed fracture analysis. Ball reported that 71% of fractures were to the upper limb (8). Oliver and colleagues surveyed playground related activities attendance between 1978 and 1979 and showed that nearly one quarter (24%) of the injuries were skull and limb fractures (81). Moreover, fractures among children under 10 years old increase with age, as do dislocations, strains, and sprains, and they occur more often in boys (102).

Injuries in children are often of multiple-category, in that there is a combination of fractures, open wounds, superficial injury, dislocations, strains, and sprains, burns, and intracranial injury. Spady reported as much as 97% of injuries were of this multiple type among children aged 1 to 10 (102). Athletes who sustain a fractured mandible or maxilla almost always sustain a coexistent concussive injury (71) and the impact forces required to fracture bones, especially in children can often exceed the impact threshold to cause a mild HI or concussion (42). In the USA, the Model Systems National Database showed that 72% of patients admitted with an HI also had fractures (80). This is because individuals who sustain an injury to the head are often the victims of multiple traumas. Clearly, MSK injuries and injuries to the head are common during childhood. The sequelae of these injuries are briefly discussed in the next section.

2.1.2 Sequelae of injury

The sequelae following injury vary with the type and severity of the injury (68) and may manifest as brief symptoms (e.g. temporary pain) or persist as disabling problems causing a profound change in lifestyle. Simple daily activities like eating, playing, attending school etc. can be affected following injury. King and colleagues analysed information on youth in grades 6-10 from the Health Behaviour in School-Aged Children Survey (1993-94) and determined that 36% of youth experienced at least one injury during that year; of these, 55% lost at least one day of school or were limited in their usual activities (48). Additional problems or inconveniences include anxiety, disruptions of work schedules to attend to the child, loss of work, inconvenience of bringing the child to the hospital for parents and caregivers.

Musculoskeletal injuries are often associated with sports related injuries. The permanent sequelae after sports injuries among children were examined in a longitudinal study and classified as objective (limited joint mobility, pain on pressure, axial deviation, weakness, or shortening of a limb) and subjective (pain at rest or during exercise, and sense of unsteadiness, or paraesthesia). The frequency of permanent sequelae was high, and the most important factors influencing the likelihood were the characteristics and severity of the lession (68).

Sequelae from HI are somewhat more complex since they can be motor, cognitive, and psychosocial. They vary with the severity of HI, classified as mild, moderate, and severe using the Glasgow Coma Scale, which assesses coma and impaired consciousness for HI (88) (89) (111). Several studies show that survivors of severe HI have permanent disability, but children who have mild or moderate HI are also at risk for long-term cognitive and motor dysfunction (33). One large cohort study of children with mild HI (excluding children with skull fracture, loss of consciousness, or having been admitted to an inpatient unit) found that physical health one month after injury was identical to that of a normal population. However, the role limitation (e.g. school absenteeism) was substantially increased (17). A smaller study of children with mild HI found a slight increase in teacher-reported hyperactivity (activity and inattentiveness) 10 years after the injury, with no other differences in school performance, cognitive ability, or behavioural symptoms (14). Subtle problems of balance and response time have been show to persist for 12 weeks in children having sustained only a mild HI (32). Depending on the sequelae of the injury, some children will require specialised care. Children with minor injuries (muscle sprain or strain) may not seek care and gradually recover over time while others with more severe injuries (fracture, HI) may be hospitalised and require specialised rehabilitation services. These services can be costly particularly when provided by many different specialists including orthopaedic surgeons, neurologists, occupational and physical therapists. These costs add to the economic burden of injury on families and on society.

2.1.3 Cost of injury

Injury has a major impact on the lives of Canadians in terms of mortality, hospitalisation and economic costs. Health Canada's 1998 report, The Economic Burden of Illness in Canada, estimated that direct and indirect costs associated with illness, injury and premature death in Canada amounted to $159.4 billion in $1998 or roughly $5310 for every Canadian. The 1993 total cost was estimated at Can $156.9 billion (36). Direct costs accounted for 52.7% of the total cost, with the balance due to indirect costs

(69).The total economic burden of injury in Canada (unintentional and intentional) was 11.1%, or $14.3 billion, ranking injury as the third largest contributor to the cost of illness among all health problems (73). In the US, Guyer & Ellers estimated cost of unintentional childhood injuries at $7.5 billion, in 1982. The highest direct cost per year was among injuries caused by falls, sports, and motor vehicle occupant injuries, while the highest indirect costs were related to motor vehicle occupant injuries, pedestrian injuries, and drowning (34). With regards to injury among Canadian youth, fall related injuries were estimated to cost Canadians $630 million per year (5).

A small number of studies have estimated the costs associated with specific types of injury and among different age groups. For example, the total cost of MSK disorders in Canada in 1999 was estimated at $25.6 billion (1994) or 3.4% of the gross domestic product. Direct and indirect costs were estimated at $7.5 billion and 18.1 billion, respectively (24).

Head injuries (all ages) have been found to be relatively more costly compared to other injuries in that they accounted for only 13% of all injuries, but represented 29% of the cost of all injuries, in the USA. The total lifetime costs for patients (0-75 yr.), who sustained a HI resulting in hospitalisation or death, amounted to $37.8 billion, in 1985. Costs for children aged 0-15 years were estimated at $ 5.6 billion (70). The Centres for Disease Control and Prevention (CDC) updated these estimates using incidence data from 1995 and adjusting for inflation to yield an estimated total cost of $56 billion, $16.7 billion of which was for mild HI (113). In a sample where 71.5% were children who had sustained a HI, the direct costs of Canadian paediatric trauma was estimated to be $1 675 734 with a mean cost of $7582 per patient (27). These costs associated with HI are probably very conservative estimates given that many cases of HI go unrecorded.

2.2 IDENTIFYING CASES OF HEAD INJURY IN CHILDREN

Although several studies have been conducted to estimate the incidence rates of HI (in adults and fewer in children). Different case definitions for HI and varied methods of collecting data make it difficult to compare information from these studies and thus estimate the national incidence of HI and true impact of on society (53). Complicating efforts to establish true measures of this problem are a lack of an accepted, standard definition for HI, a limited understanding of the consequences of HI, and inadequate methods of collecting data about the incidence of HI and its outcomes (54).

The terms head injury (HI), traumatic brain injury (TBI) and acquired brain injury (ABI) are used interchangeably in the scientific literature, each with their own definition. The definition of HI has not been consistent and tends to vary according to specialities and circumstances. HI is defined as damage to the brain tissue including the brain stem, resulting from an external mechanical load. This damage occurs when a force or stress applied to the body causes a sufficient amount of distortion to the vascular or neural elements of the brain (7). According to Lehmkuhl, TBI is defined as "damage to living brain tissue caused by an external, mechanical force. It is characterised by a period of altered consciousness (amnesia or coma) that can be very brief (minutes) or very long (months/indefinitely) (57). ABI is defined as any type of sudden injury that causes temporary or permanent damage to the brain. The damage may be the result of some kind of trauma to the head, such as concussion or a motor vehicle accident or could be associated with other factors such as anoxia, toxicity, infection, or a cerebral vascular accident (12).

The Glasgow Coma Scale is the internationally accepted measure to classify the severity of HI (e.g. mild, moderate, and severe) (111). These levels are differentiated clinically based on the individual's level of consciousness assessed immediately after the injury (2). Differences in admission criteria also may affect severity classifications. For moderate to severe HI's (Glasgow coma scale (GCS) score 3–12), the classification does not usually pose any problems, as patients remain in hospital for several days or weeks. For mild HI (GCS 13–15) (also called mild traumatic brain injury, concussion, minor brain injury, or minor head trauma), the classification is less obvious (88) (97) (112). One reason may be the short stay in hospital for such patients. Another reason may be variations in the definition of mild HI in cases where patients may be fully awake with no neurological deficits on admission to hospital. In a more recent classification, "mild HI" is defined as GCS 14–15 and/or loss of consciousness without focal neurological deficits, while "minimal HI" is defined as GCS 15 without loss of consciousness (103). Although the distinction between mild HI and more severe HI seems straightforward, establishing definitive, measurable criteria to identify and quantify the occurrence of mild HI has proven challenging because clinicians and investigators have been using different diagnostic criteria and methodologies to study this condition (96).

Other confounding variables in the epidemiology of HI exist. Many patients with mild HI may not present to the hospital, and the ones who do present may be discharged at the ED without adequate documentation with regards to their Hi diagnosis. This is important because over 85% of Hi cases are considered as mild HI (10) (11). Severe HI with associated death at the scene of the accident or during transport to hospital also may not be accounted. Differences in case definition also exists, not all studies include skull fractures without other neurologic symptoms, and some exclude immediate deaths that do not involve hospitalisation (11).

Differences in the use of diagnostic tools further complicate the study of HI in children. Before the availability of computed tomography (CT) imaging, skull radiographs were a common means to evaluate children with HI. Skull radiographs may identify skull fractures, but they do not directly show brain injury or other intracranial trauma. Although intracranial injury is more common in the presence of a skull fracture, many studies have demonstrated that intracranial lesions are not always associated with skull fractures and that skull fractures do not always indicate an underlying intracranial lesion (94). Magnetic resonance imaging (MRI) is another available modality for neuroimaging that is increasingly regarded as essential for the detection of mild HI in individuals who may have experienced clinically significant HI. However, the use of these techniques with young children is problematic (115). This procedure requires children to remain still during the test. Although MRI has been shown to be more sensitive than cranial CT in detecting certain types of intracranial abnormalities, CT is more sensitive for hyperacute and acute intracranial hemorrhage (especially subarachnoid hemorrhage). CT is more quickly and easily performed than MRI, and the costs for CT scans are lower than those for MRI (3). Moreover, the evaluation using these tools and management of injured children may be influenced by local practice customs, settings where children are evaluated, the type and extent of financial coverage, as well as the availability of technology and medical staffing.

Inconsistencies (or lack of uniformity) in the definitions and classification of HI, along with discrepancies in detection and data collection, has made it difficult to describe epidemiology of HI accurately. It is therefore important to ensure that data sources used in studies on HI are accurate and valid. The next section addresses some of the different data sources for injury, including HI.

2.3 DATA SOURCES FOR CHILDHOOD INJURY

2.3.1 Background

Information about paediatric injury in Canada can be gleaned from a number of sources. These include population surveys (e.g. National Longitudinal Survey of Children and Youth and the National Population Health Survey), medical record reviews, injury surveillance systems and hospital and trauma registries (including physician claims databases) (85). These data sources provide important information on how injuries happen - information that provides insights useful for prevention. In the sections that follow, a discussion of injury surveillance systems and use of physician claims data in the context of paediatric injury (specifically MSK injury and HI) is provided. The type of data available from these sources, as well as the strengths and limitations of each source will be discussed. Also, the studies that compare the data sources, including the methodologies used to do so, are presented and critiqued.

2.3.2 Injury surveillance systems

Injury surveillance systems are essential to the development of effective injury prevention programs. When based in ED's, they provide better estimates of the magnitude of the injury problem than mortality data alone (66). The standard definition of surveillance used by the WHO is: the ongoing, systematic collection, analysis, interpretation of health data essential to the planning, implementation, and evaluation of health practice, closely integrated with the timely dissemination of these data to those who need to know (119). In other words, it involves the keeping of records on individual cases, assembling information from those records, analysing and interpreting this information, and reporting it to health care practitioners, government officials, international agencies, the general public and anyone else with an interest in public health.

2.3.2.1 National Surveillance System: Canadian Hospitals Injury Research and Prevention Program (CHIRPP)

The national surveillance system Canadian Hospitals Injury Research and Prevention Program (CHIRPP) was developed in 1990 and has become a primary source of information on patterns of childhood injury in Canada (62) (63) (66) (84) (106).

CHIRPP operates as an ED based injury surveillance system in 10 paediatric and six general hospitals in seven provinces and one territory. The system includes data for all children presenting to the ED at the hospitals for an injury or poisoning. Accompanying adults (or the children, if old enough) complete a one page questionnaire about the circumstances of the injury, and physicians also record clinical information (including diagnosis or nature of injury and body part) on the back of the same form. The data collected by CHIRPP include information about the injured person: date of birth, sex, home language, and postal code, and the details about the injury circumstances (date and time, safety devices, vehicle seating position). In addition, a single variable describes disposition (e.g. advice only, follow-up, or admitted) and is often used as an indicator of severity. The translations of narratives describing circumstances in which injuries occur are coded into variables using a sophisticated coding system. Data are collected at each hospital, then sent to the head office in Ottawa where they are collated and analysed to provide monthly reports of injury in children and adults across the country. The principal variables that describe injury circumstances and some of the values they can take are shown in Table 1.

Table 1 : Principal CHIRPP variables used to describe injury circumstances

Variables	**Examples**
Location	Own home, school, public park, highway
Area	Bathroom, stairs, swimming pool, bicycle path/lane
Context	Pedestrian, informal sports, food preparation, eating
Breakdown event	Fall on same level, collision, spill, structural fire, failure, malfunction
Breakdown, mechanism or contributing factors	Window glass, dog, television, barbecue, hammer, acetaminophen, dishwasher detergent, coffee table, ice hockey, light bulb, iron, radiator, lawn mower, swing
Intent	Unintentional, intentional self harm, maltreatment by parent or caregiver, sexual assault

In the table, a *breakdown factor* is an item whose failure or malfunction led to the injury (swing whose chain broke). A *mechanism factor* is one that directly caused the injury (swing, if it was in motion and hit a child who was running). *A contributing factor* is one involved in the injury that did not malfunction and was not the direct cause (swing, if a child fell from it) and also includes any specific sport or the involvement of drugs or alcohol (66).

2.3.2.2 Strengths and limitations of CHIRPP

Several studies have examined the quality of data collected using the CHIRPP system. The principal strength of CHIRPP is that it provides information on how injuries happen. Information reported directly by patients or their parents is particularly valuable, as they know most about how the injury occurred. Some have criticised CHIRPP for its lack of representativeness, because only three communities (one of which is Montreal), in which all hospitals with ED's participate, can provide population based rates. The 16 participating hospitals are a small sample of the more than 750 Canadian hospitals that provide ED treatment of injuries. Because they are not representative, it is inappropriate to use the data to estimate the numbers of injuries in Canada, or even the number treated in Canadian ED's (63). Even in communities that have complete coverage of ED visits, some injuries are not captured. This includes those for which treatment is not sought and those treated elsewhere. Underestimation of seriously injured patients can also occur because they bypass the usual registration procedures. However, CHIRPP co-ordinators usually can obtain information about these patients from medical records (106). Fatal injuries were under-represented because some victims who die immediately after being injured are never brought to hospital. Moreover, no follow-up is done to identify deaths that occur after patients leave the ED. Furthermore, the database contains no information on the duration of hospitalisation or on sequelae because data are based only on what is known in the ED. Also under-representation of older adolescents and adults is reported because of the high proportion of children's hospitals in the program. Even before teenagers become too old to be treated at paediatric hospitals, they are increasingly likely to seek care at general hospitals (66).

Quality control of CHIRPP data, particularly with respect to capture and accuracy of coding is continuous. As of 1996, at the 14 hospitals for which estimates were available, the median capture was 88% (range 24% - 100%). More recent research has showed that the capture rate at specific CHIRPP centres varies from 30% to 90% (63).

In 1997, Macarthur estimated the reliability and validity of proxy respondent information in the CHIRPP system. The test-retest method determined reliability, with the Kappa coefficient quantifying agreement between respondent information provided in the ED and later during a telephone interview. Agreement was high for all items (variables listed in Table 1), Kappa coefficients ranged from 0.79 (substantial agreement) to 1.00 (perfect agreement). Respondent view of the injury event, age of the child, language of the form, or level of respondent education did not significantly affect reliability. Validity was determined by measuring the agreement between respondent information and that provided by an independent witness, where the witness information was considered to represent the truth. Kappa coefficients were greater than 0.65 for all but one item (safety precaution use), and the positive predictive value of respondent information for item categories whose prevalence was ≥ 0.25 ranged from 0.82 to 0.95. The authors concluded that proxy respondent data on childhood injury are both reliable and valid (61).

Macarthur and Pless calculated CHIRPP's sensitivity based on the assumption of complete capture of childhood injuries presenting to the Children's Hospital of Eastern Ontario. Their results suggest that CHIRPP sensitivity would decline to 20%; 95% Confidence Interval (CI) 18% to 22%) and a capture rate of 90% would give a CHIRPP sensitivity of 59%; 95% CI 57% to 61%. The authors concluded that there are systematic errors in CHIRPP capture. For example, adolescents are systematically missed by the surveillance system. This error limits the use of CHIRPP data to determine priorities, identify populations at risk, and evaluate control programs for injuries that predominantly affect this age group. In such situations, supplementary data from general hospitals may be necessary. In summary, they suggest that CHIRPP data may be useful for the identification of emerging problems and for hypotheses generation, but these data should be used cautiously in studies of etiology, given the systematic errors in capture (63).

Pickett compared injuries to Canadian youth (11–15 years) identified from a population based health survey (WHO - Health Behaviour in School-Aged Children Survey, (WHO-HBSC)) with youth injuries from CHIRPP. Comparisons focused on external causes of injury, and examined whether similar rankings of injury patterns and hence priorities for intervention were identified by the different systems. The results suggest that the patterns of injury occurrence and the priorities for youth injury prevention that emerged from the WHO-HBSC were similar to those identified within the Kingston CHIRPP system. This was true for the four variables examined to describe external causes (mechanism, object, location, and activity). Although the CHIRPP and WHO-HBSC comparison was made in an indirect manner, the authors concluded that it is reasonable to assume that CHIRPP data can be used to establish national priorities. Despite the fact that CHIRPP is not a population based injury surveillance system, nor was it ever intended to provide estimates of the burden of injury among Canadian children and youth (84).

In summary, CHIRPP provides rich information on the circumstances in which injuries occur that cannot be obtained elsewhere. Despite its limitations (e.g. lack of severity of injury) CHIRPP data have relatively high quality. We believe that CHIRPP data can thus be used as a gold standard of measure when comparing against another source of injury data. The next section reviews what is known about an alternative database for the study of injury (physician claims data), its strengths and limitations, availability and accuracy.

2.3.3 Physician claims databases

Researchers have frequently used physician claims database to describe the epidemiology of hospitalised injuries because it is readily available, inexpensive to acquire and usually encompasses a well-defined population. Physician claims databases use a standardised coding system for diagnoses and services, (e.g. the International Classification of diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnostic coding system) (40). This system makes it possible to describe the injury according to its nature, body part (N codes), and according to the external mechanism (E codes) (45). As such, physician claims databases can facilitate research in terms of selection of populations for study, adjustment for severity of diagnosis, assessment of complications of therapy, or the identification of claims of interest for cost determination.

2.3.3.1 Provincial physician claims database: Régie de l'assurance maladie du Québec (RAMQ)

The Régie de l'assurance maladie du Québec (RAMQ) or Quebec Health Insurance Agency is the provincial universal health insurance program. Similar to other Canadian provinces (93), a provincial health insurance agency administers the universal health plan, which includes the registration of provincial beneficiaries and payment of physicians (i.e. physician claims data). Services provided to Quebec residents outside of the province or country by physicians also are recorded and paid by the Quebec health insurance agency (RAMQ). In Quebec, the majority of the 17,000 licensed physicians are paid on a fee-for-services basis meaning that there is a claim record for each service delivered to a Quebec beneficiary. However, there are also some physicians that are paid by salary, and a minority who have opted out of the provincial insurance system (and are paid directly by the beneficiary) (87).

Information in the RAMQ database about a patient's clinical conditions is in the form of diagnostic codes specified by the ICD-9-CM. Physicians are generally required to report their diagnostic assessment via these codes to be reimbursed for their services. The codes are organised within broad categories. Some of these categories represent various types of conditions (e.g. injuries, neoplasm), while others reflect anatomic locations (e.g. circulatory, digestive) and one category is reserved for symptoms, signs, and ill-defined conditions. Three-, four-, and five-digit codes are listed, representing increasing levels of specificity. For example, the three-digit code 854 indicates HI (i.e. concussion), while the fourth digit specifies the manifestation (e.g. 8541 HI with intracranial wound). Table 2 presents some variables included in the RAMQ database.

Table 2 : Principal RAMQ variables

Variables	Examples
Scrambled personal insurance number	AAAA 00000000
Age categories	1-4, 5-9…up to 85
Sex	Female, Male
Postal code	A0A0A0
Scrambled personal physician number	161318
Physician speciality	Surgeon, paediatrician
Procedure codes	1320 Simple laceration (face & neck)
	8258-8259 Head tomography
Diagnostic codes	8540 Concussion
	810-819 Fractures – upper extremity
Cost of procedure	$100

2.3.3.2 Strengths and limitations of RAMQ

Physician claims data are primarily used for reimbursement and accounting purposes. However, this database has been used in research, including patient utilisation of health services, monitoring patient outcomes, and evaluating the appropriateness and effectiveness of treatment procedures for various medical problems. The advantages of using such databases have been described by many authors (22) (59) (83) (86) (95) (121) and may be categorised with respect to scope, flexibility, cost and statistical power. Databases can be comprehensive if they link physician, drug, hospital, and other medical care utilisation (116) allowing for the examination of many components of care and relationships between them. As claims data typically are used for payment purposes, claims databases are generally complete, meaning that a high proportion of all patient encounters or events in the target population appear in the database (108). Databases are flexible in the sense that they provide various methodological options, (e.g. control-group selection, study period). Because patients and providers are never contacted for data collection purposes, research activities using such a database are nonintrusive (59). Physician database research is less costly and time consuming than clinical trials (104). Additionally, when databases are sufficiently large, it is relatively easy to obtain an adequate number of cases for statistical tests. Thus claims database research provides considerable statistical power at relatively low cost. In the USA, some evidence suggests that the quality of claims data has improved over time because accurate discharge information is now a requirement for reimbursement (29) (43).

While claims database research provides a number of advantages over other types of research, it has its share of limitations that can impact the validity of study results (30) (31). Limitations associated with physician claims data include inaccurate coding that is thought to be due to patient complexity, vague context of ICD-9-CM code definitions, institution-specific variations in coding practices, and financial incentives to record certain diagnoses (29) (39) (43). Physician claims data are not collected for research purposes, and concern is often expressed about the validity of diagnostic information (43) (59) (92) (107). Diagnostic information is generally not audited for accuracy, and is not coded according to clear standards. The literature examining the accuracy of physician claims data is presented in the following section.

2.4 STUDIES COMPARING PHYSICIAN CLAIMS DATABASES WITH OTHER DATA SOURCES

Several studies have examined the accuracy of physician claims databases (or administrative databases) by comparing this data to that from other sources. Studies assessing the accuracy of coding in physician claims data generally refer to the overall rate of agreement between claims data and other data, and the sensitivity and specificity of the claims data. Overall agreement is the rate at which the claims and other data agree about whether a patient has a given medical condition or received a specific service. Sensitivity is the likelihood of identifying true positives, or the rate at which the data is able to identify patients who, have the condition or received the health care intervention of interest. Specificity is the likelihood of identifying true negatives, or indicating that the condition or procedure of interest did *not* exist or occur, assuming the information in other data sources is correct. For most conditions and procedures, claims data have better specificity than sensitivity (26) (29) (43) (92).

Patient self-reported health problems (e.g. hypertension) have been compared with diagnoses recorded within medical claims and showed modest concordance (75) (91). However, self-report likely underestimates the accuracy of diagnostic codes in claims data because patients are not necessarily aware of all diagnoses recorded by their physicians (22).

A small number of studies have compared two data sources assuming that the medical chart is a gold standard (26) (56) (92) (105). Direct comparisons between medical chart documented diagnoses by physicians and diagnostic data recorded in physician claims data are generally associated with high degrees of concordance (46) (120). But investigation has been limited to a select number of conditions (23), or a small number of patients and physicians (120). Medical record review is also subject to measurement error including incorrect or incomplete documentation, illegibility of provider notes, missing laboratory or other reports, and varying levels of abstractor skills (60) (86). Nevertheless, medical records are rich in clinical data and are frequently used as the standard against which to judge the accuracy of other data sources, including physician claims database (13) (30) (31).

Most studies that have evaluated agreement between claims data and medical records have used data from hospitalisations. The National Diagnosis Related Group (DRG) Validation Study used data from 1984-1985 and found that the overall agreement rate between diagnoses coded in the claims data and documented in the medical record was 78.2%, but the level of agreement ranged from 52.7% to 91.4% across conditions (29). In California, Romano & Mark conducted a study using data from a hospital discharge database. Their results suggest that the sensitivity of coding for eight conditions ranged from 65% to 100%, while the specificity ranged from 98.8% to 100%. Specifically, hypertension was the most under-reported condition; sensitivity for the remaining conditions was 88% or more. In the same study the ranges for the sensitivity and specificity of coding for 16 procedures were 21% to 94% and 99.5% to 100%, respectively. Non-invasive procedures tended to be under-reported, while the sensitivity of coding was greater than 90% for specific procedures (e.g. bronchoscopy and chemotherapy) (92).

A few studies have analysed the ability of physician claims data to identify patients with specific conditions (e.g. hypertension, stroke) and whether particular services were provided. When using a combination of encounter and pharmacy claims to identify persons with hypertension, there was a 96% agreement rate with medical records about who had hypertension (86). Another study reported that the administration of immunisations to children and early initiation of prenatal care had agreement rates of 70% and 67%, respectively. The lower rates of agreement for immunisation and prenatal care were attributed to reimbursement policies where these services did not need to be separately billed for reimbursement (i.e. global billing) and thus were not captured in physician claims data (26) (30).

Very few have examined the accuracy of physician claims data for trauma and injury. Hunt and colleagues assessed the accuracy of physician database in recording information about trauma patients. The number of adults with a specific type of injury (e.g. thoracic aorta injury, abdominal injury, HI) identified in the North Carolina Trauma Registry (NCTR) were compared to the numbers of patients with same injuries found in the physician claims data over the same time period. Their results suggest that the type of injury, injury severity, use of specific procedures, and complications were all under-reported in physician claims data. There were however no significant differences between the data sources with regards to recording the number of HI cases (38).

In Canada, in 2000, the sensitivity of using physician claims data for injury ascertainment was examined by Tamblyn. She conducted her study using a cohort of 1181 elderly who were treated for injuries at the ED of one of 10 hospitals. The most common injuries were fractures (55%) and lacerations (19%). The clinical record of the type and date of injury was compared with diagnostic and procedure codes in the RAMQ database for the same patients. Their results showed that the combination of treatment procedure codes and diagnostic codes in the RAMQ database provided a more sensitive measure of injury occurrence and a sensitive indicator of some common injuries. Sensitivity varied by injury type, from a low of 14% for abrasions to a high of 97.2% for hip fractures (109). More recently, the same authors validated diagnostic codes within RAMQ using the medical chart as a gold standard. The goal was to determine the sensitivity and specificity of physician claims diagnoses for surveillance of 14 drug disease contraindications used in a drug utilisation review. The RAMQ data was found to have diagnostic codes and conditions that were highly specific but that varied greatly by condition in terms of sensitivity (116).

Taylor appears to be the only one to have used physician claims in the context of childhood injury. His work however did not examine the accuracy of this data source but rather the ability of physician claims data of a tertiary care paediatric ED in Halifax, Canada to predict the number of future ED visits for trauma compared to those for respiratory infection. They concluded that billing data provide a good measure of future trauma occurrence risk among children. As such, he assumed the physician claims data were accurate in identifying trauma occurrence without evidence to support this (110).

More recently, in the USA, 2005 the validity of Maryland Hospital Discharge (MHD) data was examined for identifying and characterising HI-related hospitalisations among persons aged one to 65 years. To do this, all HI-related hospitalisations in 1999 were identified using the MHD. Also the type and severity of HI reported by the MHD data were compared with clinical information abstracted from a random sample of medical records. MHD data were compared with those found in the medical record (gold standard) with regards to the different types of HI. Relatively good concordance was found between the two data sources for presence of skull fractures and intracranial lesions (Kappa = 0.73 and 0.83, respectively) Also the results of this study suggested that HI cases, especially mild ones, were under-reported in the MHD data, particularly among the young adult age group. Moreover, MHD data were better at detecting anatomic injuries, specifically skull fractures and intracranial lesions. Since the ICD-9-CM classification system does not have specific injury codes for neurological deficits or amnesia, these two types of HI were under-reported in the MHD database (101).

To our knowledge, RAMQ data have never been compared to those of an injury surveillance system, particularly, in the case of paediatric HI. Given the advantages of physicians claims data described above, it would perhaps be more economical to use the population based RAMQ database rather than CHIRPP data to calculate the yearly incidence rate (i.e. rate at which new cases occur) of HI among children. The incidence of HI in children in Quebec (or in Canada) is currently unknown. The literature reviewed above however provides some insight into the most appropriate methods and statistical procedures to use when comparing two data sources and validating one against the other.

CHAPTER 3: METHODS

This thesis is presented in the form of "thesis with article". In this chapter, the study population, procedure and variables under study are described including a brief explanation of the context of the study.

3.1 CONTEXT

The present study was part of a larger study in progress at the time when I was doing my graduate work. It sought to determine if previous HI is a risk factor for subsequent HI and involved children who consulted the ED for an injury, of either one of the two paediatric hospitals of Montreal between December 2000 and March 2003. A total of 11867 subjects were recruited. The present study utilised a subset of these data, focusing on data collected for the first consecutive 3145 children recruited from December 2000 to October 2001.

3.2 DESIGN

This study was comparative in nature using cross sectional data collected as part of the cohort study described above.

3.3 STUDY POPULATION AND RECRUITMENT

3.3.1 Subject recruitment

The data for 3145 injured children were routinely collected at the EDs of the two paediatric hospitals (the Montreal Children's Hospital and Saint Justine Hospital) in Montreal that have taken part in CHIRPP for the past 10 years. Each accompanying adult or child older than 14 years presenting at ED for an injury completed a one-page self-administered CHIRPP questionnaire about the circumstances of the injury. Also on the back of this form, the physicians record the following clinical information: diagnostic codes, injured body part and treatment provided. The child's personal health insurance number (a 10-digit number that provides a unique identification number for each beneficiary of the Quebec health insurance plan), date of birth, sex, postal code and date of visit were also recorded on the CHIRPP sheet. A small number of forms were completed by a clerk working with CHIRPP data at the hospital using information recorded in the emergency or medical report. I visited each hospital on a weekly basis to collect completed CHIRPP forms and entered the data for this study into a database for three different groups of children according to specific inclusion and exclusion criteria.

3.3.2 Inclusion criteria

The HI group was defined as children with a diagnosis of HI (e.g. skull fracture, minor HI, concussion, and multiple injuries with associated HI) as recorded on the CHIRPP form. When a child sustained multiple injuries and one of the injuries included a HI, the child was classified into the HI group. The Probable HI group included children with injuries to the eyes, face and teeth or isolated facial lacerations only when accompanied with one of the following mechanisms of injury: struck forcefully against a hard surface, a fall from a height or both. The third group consisted of children diagnosed with an musculoskeletal (MSK) injury of the upper or lower extremity (e.g. fracture, laceration, sprain, and dislocation).

3.3.3 Exclusion criteria

Children under one year of age were excluded because they may have not received their permanent RAMQ number and we would be unable to link them with the RAMQ database. Children with burns or poisoning were also excluded.

3.4 PROCEDURE

The procedure involved several stages. First, the physician - recorded diagnostic codes in the CHIRPP database were used to separate the children into three groups: (HI, Probable HI and MSK). Second, a file containing this CHIRPP based information including the child's health insurance number was sent by registered mail to the Service des statistiques of the RAMQ. They returned to us the complete registry of services paid to fee-for-service physicians who provided care for the 3049 children during 12 months after the index visit for an injury. Data were unattainable for 96 children due to missing RAMQ numbers. The confidentiality of subjects was maintained using a scrambled RAMQ number. Diagnostic data from physician claims data and injury surveillance were then linked, for each child, by the investigators of the larger study on risk of second HI using the RAMQ numbers. Finally, to enable a comparison between the two data sources with respect to injury diagnosis, the RAMQ data were grouped into the same three diagnostic categories. This was done using an algorithm (formed of ICD-9-CM diagnostic and procedure codes) described below.

3.4.1 Algorithm development

An algorithm based on ICD-9-CM diagnostic codes and procedures codes was developed by the research team to enable separating the RAMQ data according to three diagnostic categories: HI, HI probable, and MSK injury. This algorithm was validated by a team of researchers (including an ED paediatrician) with a sample of the first 500 children recruited. Detailed information about the development and validation of this algorithm are presented in the next section.

3.4.1.1 Identification of diagnostic codes

First, the literature on HI was reviewed to obtain definitions to assist in determining the codes used in the RAMQ database to indicate encounters for an HI. Several definitions of HI (12) (57) (74) and several diagnostic terms used to define an HI were found, including concussion, wounds to the head, etc. The ICD-9-CM diagnostic codes containing the words head, cranium, cerebral, cervical, face, temporo-maxillaire and neck were then identified, because injuries to these body parts can be considered as a probable HI (49) (74) (98) (100). When several articles used a diagnostic code to define HI, the team considered the code indicating an HI; when less than seven articles used a particular code for HI, the team chose to use this code to indicate Probable HI. When a diagnostic code was considered to indicate an HI by only one article, the code was not retained to define an HI, in the context of the present study.

The choice of diagnostic codes indicating HI was further validated by a paediatric orthopaedic surgeon. The recent proposed definition of HI by the Centres for Disease Control and Prevention supports the choice of codes (77).

The next step of the development of the algorithm was to determine the *non-specified* diagnostic codes contained in the RAMQ database that could indicate an HI. This was done to ensure a maximal capture of all cases of HI. Once again, all diagnostic codes related to the head, face and neck with the mention *not specified* or *without precise details* were listed. These codes, combined with other codes such as procedure codes (indicating the use of a procedure specific to the management of HI) in the RAMQ database, could indicate that a child had an HI.

3.4.1.2 Identification of procedure codes

The procedure codes (indexed in the Medical Handbook published on the official Web site of the RAMQ) indicate the medical procedure provided and the body part involved. Decisions were made regarding each code to determine whether it represented HI, probable HI or no HI. The procedures codes: 8259, 8570, 8010, 8013, 8023, 8031, 8034, 8036, 8123 and 8124 indicated the presence of an HI, while the codes: 7500-7507 and 7595-7598; 8258, 8259 and 8570 were identified as being related to a HI. Other procedure codes (1320, 2113, 2507, 2512-2518, 2505, 2509, 2517 and 2520-2527) were considered as codes associated to probable HI. A list of the pertinent diagnostic and procedure codes associated with injury investigated in this study are presented in Table 3.

Table 3 : ICD-9-CM diagnostic codes and procedure codes used in algorithm for classifying HI and MSK injury

Skull fractures	
800-8009	Fracture of vault of skull
801-8019	Fracture of base of skull
803-8039	Other and unqualified skull fracture
Intracranial lesions	
8001	Vault fracture, closed with cerebral laceration and contusion
8002	Vault fracture, closed with subarachnoid, subdural and extradural hemorrhage
8003	Vault fracture, closed with other unspecified intracranial hemorrhage
8006	Vault fracture, open with cerebral laceration and contusion
8007	Vault fracture, open with subarachnoid, subdural and extradural hemorrhage
8008	Vault fracture, open with other and unspecified intracranial hemorrhage
8011	Basilar fracture, closed with cerebral laceration and contusion
8012	Basilar fracture, closed with subarachnoid, subdural and extradural hemorrhage
8013	Basilar fracture, closed with other and unspecified intracranial hemorrhage
8016	Basilar fracture, open with cerebral laceration and contusion
8017	Basilar fracture, open with subarachnoid, subdural and extradural hemorrhage
8018	Basilar fracture, closed with other and unspecified intracranial hemorrhage
8031	Other skull fractures, closed with cerebral laceration and contusion
8032	Other skull fractures, closed with subarachnoid, subdural and extradural hemorrhage
8033	Other skull fractures, closed with other and unspecified intracranial hemorrhage

8036	Other skull fractures, open with cerebral laceration and contusion
8037	Other skull fractures, open with subarachnoid, subdural and extradural hemorrhage
8039	Other skull fractures, open with other and unspecified intracranial hemorrhage
8041	Multiple fractures involving skull, closed with cerebral laceration and contusion
8042	Multiple fractures involving skull, closed with subarachnoid, subdural and extradural hemorrhage
8043	Multiple fractures involving skull, closed with other and unspecified intracranial hemorrhage
8046	Multiple fractures involving skull, open with cerebral laceration and contusion
8047	Multiple fractures involving skull, open with subarachnoid, subdural and extradural hemorrhage
8049	Multiple fractures involving skull, open with other and unspecified intracranial hemorrhage
851-8519	Cerebral laceration and contusion
852-8529	Subarachnoid, subdural and extradural hemorrhage following injury
853-8531	Other and unspecified intracranial hemorrhage following injury
8479	Sprain of neck unspecified
9083	Trauma of cerebral vessels
Concussions	
850	Concussion
851	Cerebral laceration and contusion
8510	Cerebral laceration and contusion without intracranial wound
8511	Cerebral laceration and contusion with intracranial wound
8519	Cerebral laceration and contusion unspecified
8509	Concussion unspecified
852	Subarachnoid, subdural and extradural hemorrhage
8520	Subarachnoid, subdural and extradural hemorrhage without intracranial wound

8521	Subarachnoid, subdural and extradural hemorrhage with intracranial wound
8529	Subarachnoid, subdural and extradural hemorrhage without precise details
853	Hemorrhage intracranial without precise details
8530	Hemorrhage intracranial without wound intracranial
8531	Hemorrhage intracranial with wound intracranial
8539	Hemorrhage intracranial unspecified
854	Intracranial injury unspecified
8540	Unspecified intracranial injury without hemorrhage intracranial
8541	Unspecified intracranial injury with hemorrhage intracranial
8549	Intracranial injury with unspecified location
Fractures – Upper extremity	
810	Fracture of clavicle
811	Fracture of scapula
812	Fracture of humerus
813	Fracture of radius and ulna
814	Fracture of carpal bone(s)
815	Fracture of metacarpal bone(s)
816	Fracture of one or more phalanges of hand
817	Multiple fractures of hand bones
818	Fracture of any of the following: the scapula/clavicle, ulna/radius, carpal, hand
819	Multiple fractures involving both upper limbs
Fractures – Lower extremity	
820	Fracture of neck of femur
821	Fracture of other and unspecified parts of femur
822	Fracture of patella
823	Fracture of tibia and fibula
824	Fracture of ankle
825	Fracture of one or more tarsal and metatarsal bones
826	Fracture of one or more phalanges of foot
827	Fracture of the following: femur, patella, tibia/fibula, ankle, foot

828	Multiple fracture involving both lower limbs, lower with upper limb, and lower limb(s) with rib(s) and sternum
829	Fracture of unspecified bones
Subluxation - upper extremity	
831	Dislocation of shoulder
832	Dislocation of elbow
833	Dislocation of wrist
834	Dislocation of finger
Subluxation – lower extremity	
835	Dislocation of hip
836	Dislocation of knee
837	Dislocation of ankle
838	Dislocation of foot
939	Other, multiple dislocations
Laceration	
871	Open wound to eyeball
872	Open wound to ear
873-8739	Other open wound of head, face, nose (except ICD-9-CM 851-854)
874-8749	Open wound of neck
880	Open wound of shoulder and upper arm
881	Open wound of elbow, forearm and wrist
882	Open wound of hand except finger(s) alone
883	Open wound of finger(s)
884	Multiple and unspecified open wound of upper limb
890	Open wound of hip and thigh
891	Open wound of knee, leg (except thigh) and ankle
892	Open wound of foot except toe(s) alone
893	Open wound of toe(s)
894	Multiple and unspecified open wound of lower limb
Unspecified diagnostic codes	
8798	Multiple wound with unspecified location
8799	Multiple wound with unspecified location

929	Crushing unspecified
9599	Different traumatises without precise details
Procedure codes	
1320	Simple laceration (face & neck)
2113	Incision, drainage of skull
2505-2527	Treatment for trauma to skull or face
7500-7507	Treatment for skull fracture
7595-7598	Treatment for laceration of skull
8010-8030	X-ray skull or face
8258-8259	Tomography of head
8570	MRI head or neck

3.4.1.3 Final algorithm

All diagnostic and procedure codes were identified for use in creating three groups of children: HI, probable HI or MSK injury.

The HI group was defined as all children who received medical services for an HI (ICD-9-CM diagnostic codes 800, 801, 803, 804, 850-8549, 9083 or procedure codes specific to HI 7500-7507, 7595-7598) or either one of these codes. The Probable HI group included all children who had a combination of the following diagnostic (ICD-9-CM 802, 830, 873, 910, 920, 959) and procedure codes (1320, 2113, 2505-2527, 8010-8030 8258-59, 8570). For example, a child having a visit billed with a diagnostic code for concussion (ICD-9-CM 8540) was assumed to have had a HI. A child with a diagnostic code of imprecise trauma (8290) and a procedure code indicating magnetic resonance imaging of the head (8570) was assumed to have had a Probable HI. The MSK group consisted of all children using medical services for an injury to the upper or lower extremities (ICD-9-CM diagnostic codes 810-817, 820-829, and 831-839).

Finally, to validate the accuracy of the algorithm, we used data for the first 500 children who sought care at the ED's of the two hospitals (December 2000 to January 2001). CHIRPP and RAMQ data were linked using the children's health insurance number to determine if the algorithm allowed us to identify all the children who had an HI (as recorded on the CHIRPP form) and whether any diagnostic or procedure codes had been forgotten in the algorithm. Analyses of codes for each child revealed that the diagnostic code 9083 – indicating Trauma to cerebral vessels in the RAMQ database was missing from the algorithm. But this code always related to a diagnosis of HI (e.g. skull fracture, minor HI, concussion, intracranial injury and multiple injuries with associated HI) recorded on the CHIRPP form. This code was subsequently included in the algorithm used by the biostatician who generated the data analyses.

3.5 ETHICS CONSIDERATIONS

The institutional review boards at the hospitals approved this study. Permission to access the physician claims database was obtained from the Quebec Commission for Access to Information.

3.6 ANALYSIS

Several measures of agreement were used to determine the concordance between injury diagnoses using the two data sources: an injury surveillance system (CHIRPP) and a physician claims database (RAMQ). They include overall agreement, Kappa statistic, sensitivity and specificity. Below, they are described including how they were calculated.

3.6.1 Overall agreement

Overall agreement is a statistical summary of concordance that ignores distinctions between positive and negative agreement (i.e., does not separately evaluate how closely the data sources agree about who is a "yes" and who is a "no"). The Kappa statistic (k) is one measure of overall agreement that is frequently used to summarise concordance between data sources because it considers chance. Kappa does not take into account the degree of disagreement between observers and all disagreement is treated equally as total disagreement. Kappa can be weighted to reflect the degree of disagreement (21). The strength of agreement for the Kappa coefficient has been categorized as follows: 0 = poor, 0.01-0.20 = slight, 0.21-0.40 = fair, 0.41-0.60 = moderate, 0.61-0.80 = substantial and 0.81-1 = almost perfect (55).

The interpretation of Kappa is not straightforward because the statistic is affected by prevalence. For example, high levels of agreement between physician claims and medical record data may emerge with low values of the prevalence of the event of interest (18). It was suggested that Kappa may not be the best measure of agreement when validity is being evaluated and that sensitivity and specificity or predictive value be employed for dichotomous data (67). To calculate the percent overall agreement and weighted Kappa statistic a 3x3 table was created (HI, Probable HI and MSK) based on the childhood injury diagnoses obtained from the two data sources.

3.6.2 Sensitivity and specificity

Sensitivity is a measure of the validity of a screening test and is defined as the probability of testing positive if the disease is truly present. In this analysis, sensitivity evaluates how well one data source (CHIRPP) agrees with the other (RAMQ) about whether an indicator's criteria (i.e. diagnostic codes) for HI and MSK injury have been satisfied. Sensitivity for HI was defined as the probability of having an HI (HI group and Probable HI group combined) indicated in the RAMQ database given that HI was recorded as the CHIRPP diagnosis. High rates of sensitivity indicate that a data source is not substantially underestimating the number of patients who satisfy the eligibility or scoring criteria relative to the other data source.

Specificity measures how closely each data source agrees with the other on negative assessments. Specificity was defined as the probability of not having a HI recorded in the RAMQ database when HI was truly absent as indicated by the CHIRPP diagnoses. Using CHIRPP as a gold standard, we calculated sensitivity and specificity for HI and MSK injury by creating a 2x2 table and using the following formula: the HI group was combined with the Probable HI group and compared to the MSK group.

CHAPTER 4: ARTICLE

The principals results of this research project are published in *Injury Prevention*, 2005 and presented in the following article:

Concordance between childhood injury diagnoses from two sources: an injury surveillance system and a physician billing claims database.

Alla Kostylova, Bonnie Swaine, Debbie Feldman. Injury Prevention 2005 11: 186-190.

I, as the principal author, confirm my original contribution to the data collection and interpretation of the results as well as in the writing of the research article.

4.1 Concordance between childhood injury diagnoses from two sources: an injury surveillance system and a physician billing claims database

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Running head: validation of physician claims data for paediatric injury.

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4.1.1 Abstract

Objectives: 1) to determine the concordance between injury diagnoses (Head injury (HI), Probable HI or Orthopaedic Injury) for children visiting an emergency department for an injury using two data sources: an injury surveillance system (Canadian Hospitals Injury Research and Prevention Program, CHIRPP) and a physician billing claims database (Régie de l'assurance maladie de Québec, RAMQ), and 2) to determine the sensitivity and specificity of diagnostic and procedure codes in billing claims for identifying HI and Orthopaedic injury among children.

Design: In this cross sectional cohort, data for 3049 children who sought care for an injury (2000-2001) were obtained from both sources and linked using the child's personal health insurance number.

Methods: The physician recorded diagnostic codes from CHIRPP were used to categorize the children into three groups (HI, Probable HI and Orthopaedic), while an algorithm, using ICD-9-CM diagnostic and procedures codes from the RAMQ, was used to classify children into the same three groups.

Results: Concordance between the data sources was "substantial' (weighted Kappa 0.66; 95% CI: 0.63-0.69). The sensitivity of diagnostic and procedure codes in the RAMQ database for identifying HI and for orthopaedic injury were 0.61 (95% CI: 0.57-0.64) and 0.97 (95% CI: 0.96-0.98), respectively. The specificity for identifying HI and for orthopaedic injury were 0.97 (95% CI: 0.96-0.98) and 0.58 (95% CI: 0.56-0.63), respectively

Conclusion: Combining diagnostic and procedures codes in a physician billing claims database (i.e. the RAMQ database) may be a valid method of estimating injury occurrence among children.

4.1.2 Introduction

Information about paediatric injury in Canada can be gleaned from a number of sources. These include population surveys (e.g. National Longitudinal Survey of Children and Youth and the National Population Health Survey), medical record reviews, hospital and trauma registries (including administrative databases) and injury surveillance systems.[1] With regards to the latter, the Canadian Hospitals Injury Research and Prevention Program (CHIRPP) is a primary source of information on patterns of childhood injury in Canada.

CHIRPP is a computerised emergency room based injury surveillance system that operates in 10 paediatric and five general hospitals across the country. It gathers important data (e.g. mechanism of injury, nature of injury and body part) relating to children's visits to hospital emergency departments (ED) for injury. Pickett and collaborators have provided an overview of the system's strengths and weaknesses.[2] Its strengths are: 1) information on the circumstances in which injuries occur that cannot be obtained elsewhere, 2) its high rate of parental compliance and 3) its data are invaluable for the development of appropriate preventive interventions. Weaknesses of CHIRPP include its need for active co-operation of doctors and emergency staff as well as technical support (adding to the expense of running such a system), and its representativeness since the rate of children's use of ED's after sustaining an injury could vary among communities.[3][4][5] Finally, it is somewhat limited in that it does not provide data relating to injuries for which care was sought outside the ED (i.e. paediatrician or physicians office).

Physician billing claims represent another data source for injury research. Taylor et al., used the billing records (fee-for-service billing data) of a tertiary care paediatric ED in maritime Canada to predict the number of future ED visits for trauma compared to those for respiratory infection.[6] They concluded that billing data, that includes diagnostic codes based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) [7], provide a good measure of future trauma occurrence risk among children. In Quebec, the fee-for-service database of the Quebec Health Insurance Board, or the Régie de l'assurance maladie du Québec (RAMQ), was shown to provide a valid source of information for outcome assessment of injuries in the elderly.[8] The sensitivity of the claims data for the measurement of any injury was found to be 81.3%, but the sensitivities for specific injuries varied widely from 14.3% to 97.2%. The accuracy of this type of data was also found to be high in cases of cardiovascular prognosis [9], hip fracture [10][11][12] and stroke.[13] Although these data are primarily used for reimbursement and accounting purposes, physician billings claims have been suggested as an appropriate data source for quality of care assessment [14][15][16], pharmacoepidemiologic research [17], technology assessment [18], evaluation of medical care appropriateness [19] and cost utilization studies.[20] The advantages of using claims data are: 1) large samples of geographically dispersed patients, 2) longitudinal records, 3) convenience and low cost (i.e. data already collected and available), and 4) defined sampling frames.[14] [21][22][23][24][25] Limitations of these types of administrative data include inaccurate coding that is thought to be due to patient complexity, vague context of ICD-9-CM code definitions, institution-specific variations in coding practices, and financial incentives to record certain diagnoses.[9] [26][27] To our knowledge, the use of physician claims data has never been formally validated for paediatric injury, and in particular for head injury (HI).

Moreover, physician claims data has never been validated against an injury surveillance system.

The purpose of this study was to compare data gathered using the CHIRPP surveillance system with that from the physician claims files from the RAMQ (Quebec Provincial Health Insurance Board) for the same group of children who visited an ED for the same index injury. Specifically, we sought to determine 1) the agreement between childhood injury diagnoses (HI and orthopedic injury), and 2) the sensitivity and specificity of diagnostic and procedure codes in billing claims for identifying HI and orthopedic injury among children.

4.1.3 Methods

Data from the CHIRPP database were compared with that from the physician claims database of the RAMQ. CHIRPP data were collected at the ED's of the two pediatric hospitals in Montreal from December 2000 to October 2001 (i.e. Montreal Children's Hospital and Hôpital Saint-Justine). The CHIRPP database contains information about the circumstances of the injury that is completed by the patient or an accompanying adult on a one-page self-administered CHIRPP questionnaire. Also on the back of the same form, the physicians record the following clinical information: diagnostic codes, injured body part and treatment provided. The child's personal health insurance number (a 10-digit number that provides a unique identification number for each beneficiary of the Quebec health insurance plan), date of birth, sex, postal code and date of visit are also recorded on the CHIRPP sheet.

The Quebec Health Insurance Board or Régie de l'assurance maladie du Québec (RAMQ) - the government agency responsible for administering the provincial health insurance plan - uses a computerized billing service to record service use and to reimburse service providers. This database contains the physician's identification number, the patient's provincial health insurance number, the date and location of visit, type of consultation, as well as the ICD-9-CM diagnostic codes for the visit, procedure codes for services provided and the cost of these services.

4.1.4 Procedure

The records of 3145 children aged 1-18 years who sought care for an injury during the study period were identified and extracted from the CHIRPP database. Children under one year of age were excluded because they have not received their permanent health insurance number and we would be unable to link them with the RAMQ database.

The physician recorded diagnostic codes in the CHIRPP database were used to separate the children into three groups: (HI, Probable HI and Orthopedic). The HI group was defined as children with a diagnosis of HI (e.g. skull fracture, minor HI, concussion, intracranial injury and multiple injuries with associated HI). When a child sustained multiple injuries and one of the injuries included a HI, the child was classified into the HI group. The Probable HI group included children with injuries to the eyes, face and teeth or isolated facial lacerations only when accompanied with one of the following mechanisms of injury: struck forcefully against a hard surface, a fall from a height or both. The Orthopedic group consisted of children diagnosed with an orthopedic injury of the upper or lower extremity (e.g. fracture, sprain, and dislocation).

A file containing this CHIRPP based information was sent by registered mail to the Service des statistiques of the RAMQ and returned to us containing the complete registry of services paid to fee-for-service physicians who provided care for 3049 children during 12 months after the index visit for an injury. Data were unattainable for 96 children due to missing RAMQ numbers. The confidentiality of subjects was maintained using a scrambled personal insurance number.

For the purposes of this study, an algorithm was developed, and validated by a team of researchers (including an ED pediatrician) with a sample of 500 children, using ICD-9-CM diagnostic and procedure codes from the physician claims database. The algorithm was used to classify the children into the same three diagnostic groups. The HI group was defined as all children who received health services for a HI (ICD9-CM codes 800, 801, 803, 804, 850-8549, 9083 or procedure codes specific to HI 7500-7507, 7595-7598) or either one of these codes. The Probable HI group included all children who had a combination of the following diagnostic (ICD9-CM 802, 830, 873, 910, 920, 959) and procedure codes (1320, 2113, 2505-2527, 8010-8030 8258-59, 8570). For example, a child having a visit billed with a diagnostic code for concussion (ICD-9-CM 8540) was assumed to have had a HI. A child with a diagnostic code of imprecise trauma (8290) and a procedure code indicating magnetic resonance imaging of the head (8570) was assumed to have had a Probable HI. The Orthopaedic group consisted of all children using health services for an injury to the upper or lower extremities (ICD-9-CM 810-817, 820-829, and 831-839). A list of the pertinent diagnostic and procedure codes associated with injury are presented in Table 1.

Table 1 : ICD-9CM diagnostic and procedure codes associated with injury

	Definition of codes
Diagnostic codes	
800-804	Fracture - Skull & face
850-8549	Concussion
872-874	Laceration - Skull & face
830	Subluxation
910	Trauma to face
920	Contusion of eyes
959	Unspecified trauma
9083	Trauma to cerebral vessels
810-819	Fractures - Upper extremity
820-829	Fractures - Lower extremity
880-884	Open wound of Upper extremity
890-894	Open wound of Lower extremity
Procedure codes	
1320	Simple laceration (face & neck)
2113	Incision, drainage of skull
2505-2527	Treatment for trauma to skull or face
7500-7507	Treatment for skull fracture
7595-7598	Treatment for laceration of skull
8010-8030	X-ray skull or face
8258-8259	Tomography head
8570	MRI head or neck

4.1.5 Analysis

Two analyses were performed. First, we created a 3x3 table (HI, Probable HI and Orthopaedic) and calculated the percent overall agreement and a weighted Kappa statistic between childhood injury diagnoses obtained from the two data sources. Second, using CHIRPP as a gold standard, we calculated sensitivity and specificity for HI and orthopaedic injury by creating a 2x2 table where the HI group was combined with the Probable HI group and compared to the Orthopaedic group. Sensitivity for HI was defined as the probability of having a HI (HI group and Probable HI group) indicated in the RAMQ database given that HI was recorded as the CHIRPP diagnosis. Specificity was defined as the probability of not having a HI recorded in the RAMQ database when HI was truly absent as indicated by the CHIRPP diagnoses.

4.1.6 Results

The descriptive characteristics of the sample are presented in Table 2. There were more males (60.5%) than females with an injury, and across all groups, injuries mostly occurred at home (39%), followed by those at school inside and outside (21%) and in recreation centres (13%). Thirty percent of children with HI were sent home from the ED with advice only, whereas 98% with probable HI and 93% of those with orthopedic injury were treated prior to being sent home.

Concordance between the two data sources was found to be "substantial' (weighted Kappa 0.66; 95% CI: 0.63-0.69) according to the interpretation scale of Landis and Koch, and percent agreement was 81%.[28].

Table 2: Characteristics of children seeking care at two Montreal pediatric trauma centers, 2000-2001

	HI n=724	Probable HI n=423	ORTHO n=1902	Total n=3049
SEX				
Female	251 (35%)	139 (33%)	815 (43%)	1205 (34%)
Males	473 (65%)	284 (67%)	1087 (57%)	1844 (66%)
AGE				
0-4	251 (34%)	189 (45%)	343(18%)	783 (26%)
5-9	225 (31%)	157 (37%)	460 (24%)	842 (28%)
10-14	164 (23%)	62 (15%)	771 (41%)	997 (33%)
14-18	84 (12%)	15 (3%)	328 (17%)	427 (14%)
WHERE INJURY OCCURRED				
Home inside & outside	306 (42%)	276 (65%)	594 (31%)	1176 (39%)
School inside & outside	152 (21%)	38 (9%)	454 (24%)	644 (21%)
Park	66 (9%)	25 (6%)	282 (15%)	373 (12%)
Recreation center	86 (12%)	21 (5%)	275 (14%)	382 (13%)
Public place	61 (8%)	23 (5%)	204 (11%)	288 (9%)
Day care inside & outside	13 (2%)	19 (4%)	28 (1%)	60 (2%)
Other	34 (5%)	21 (5%)	60 (3%)	115 (4%)
TREATMENT				
Advice only	217 (30%)	7 (1.6%)	29 (1%)	253 (8%)
Treated, follow-up as necessary	391 (54%)	399 (94%)	703 (37%)	1493 (49%)
Treated, follow-up required	34 (5%)	15 (4%)	1062 (56%)	1111 (36%)
Short stay in emergency	26 (4%)	0 (0%)	56 (3%)	82 (3%)
Admitted	55 (8%)	2(0.4%)	51 (3%)	108 (4%)

Data collected as part of the Canadian Hospitals Injury Research and prevention Program (CHIRPP)

There were 446 exact matches for HI, 173 for Probable HI and 1849 for Orthopaedic injury. Discordant cases (n = 581 children) were individually examined to determine the underlying reasons of disagreement. Reasons for disagreement varied and some were more easily accounted for than others (Table 3). For example, among the discordant cases, 52% were billed with the diagnostic code "multiple unspecified wound or trauma" and 95% of these (n=289) were classified by CHIRPP as HI or Probable HI. The mean age of children among the discordant pairs (6.6 years) was significantly different ($p < .001$) from that of the rest of sample (8.5 years).

Table 3: Examination of discordant childhood injury cases based on physician billing records* and paediatric injury surveillance data (n=581 children)**

Reasons for discordance	Frequency	%
Billed with diagnostic code "multiple unspecified wound or trauma" (95% were classified by CHIRPP as HI or Probable HI)	304	52
Billed with diagnostic codes indicating HI or Probable HI (41% were classified by CHIRPP as Orthopaedic)	99	17
Billed with a diagnosis unrelated to injury (e.g. sinusitis, chicken pox) (96% were classified by CHIRPP as HI or Probable HI)	107	18
Billed as having an UE or LE fracture (84% were classified by CHIRPP as HI or Probable HI)	44	8
Billed with a diagnosis possibly related to HI (e.g. virus infection, nausea, headache) (100% were classified by CHIRPP as HI or Probable HI)	11	2
Lacked a procedure or a diagnostic code precluding classification into one of three groups	16	3

*Physician Billing claims database (Régie de l'assurance maladie de Québec (RAMQ)
**Canadian Hospital Injury Research and Prevention Program (CHIRPP)

The sensitivity of diagnostic and procedure codes in the RAMQ database for identifying HI and for orthopaedic injury were 0.61 (95% CI: 0.57-0.64) and 0.97 (95% CI: 0.96-0.98), respectively. The specificity for identifying HI and for orthopaedic injury were 0.97 (95% CI: 0.96-0.98) and 0.58 (95% CI: 0.56-0.63), respectively.

4.1.7 Discussion

We compared childhood injury diagnoses using CHIRPP data with that from a physician claims database for the same group of children who visited an ED for the same index injury. Our results indicate that the concordance between the two data sources is 'substantial' and that the sensitivity of claims data for identifying orthopaedic injury was higher than that for identifying HI. There are several possible reasons for the less than optimal level of concordance. First, we observed a high frequency of non-specific diagnostic codes in physician billings. It is interesting to note that of the 304 cases that were billed for 'multiple unspecified wound or trauma", 95 % (n=289) of these were classified by CHIRPP as HI or Probable HI. Another 18 % of cases (n=107) were billed with a diagnosis unrelated to injury (e.g. sinusitis, chicken pox) yet 96 % of these had HI or probable HI CHIRPP based diagnoses. It would thus appear that the physician claims database underestimates the frequency of HI (and probable HI) by approximately 12 % (i.e. (107 + 289)/3049). Age may also appear to be a factor associated with concordance between the data sources. Since, the children in the discordant pairs were significant younger than those within the sample as one would expect the diagnosis among younger children appears to be less precise.

Other possible reasons for our results include coding errors in both databases. Clearly, there are errors when completing RAMQ reimbursement forms because 107 children among the discordant pairs, who completed a CHIRPP form for an injury, were billed with a RAMQ diagnostic code other than trauma. Certain recording errors of injuries using the CHIRPP system may also exist. Physicians who write initial diagnoses not necessary complete the CHIRPP form. Sometimes this information is recorded by clerk using the child's medical file as reference. Since 99 children among the discordant pairs were billed with diagnostic codes indicating HI or Probable HI but classified by CHIRPP as an orthopaedic injury. Perhaps these children suffered multiple injuries and for some reason the physician coded the visit as one for a HI. This phenomenon is unlikely to be related to fee structure (i.e. financial incentives); reimbursement fees for a HI are not necessarily higher than those for an orthopaedic injury but appear to vary in both cases according to the time of day of the visit, day of the week of the visit, etc. Errors could also have occurred in the transcribing of physician notes onto RAMQ reimbursement forms. Finally, a small percentage of missing diagnostic codes in the RAMQ data may also have contributed to the less than perfect concordance.

Indeed, each of the databases was developed for a specific purposes and has its own strengths and weaknesses. Although CHIRPP provides important detailed information about injuries treated in an ED, one must keep in mind that the injury surveillance system is not population based. This is in contrast to the physician claims database used in this study, which covers the full continuum from ambulatory to hospital-based care, and provides information on almost all contacts with physicians in the health care system. Physician claims data are however limited to health care systems where fee-for-services payment is the predominant means of reimbursement. This is the case in Quebec and other parts of Canada, but it may differ in other countries where physicians are paid by capitation or salary. Clearly, there is no single best source for monitoring injury in a population. It would be ideal to link these data sets (injury data with administrative data) to complement the unique strengths of each type of data and provide a more complete picture of childhood injury.

To our knowledge this is the first study in Quebec that measures the accuracy of physician claims data for paediatric injury including HI. We were interested in knowing if physician claims data could be used for another purpose other than physician reimbursement. We believe this study demonstrates a new application and the potential capabilities of using diagnostic and procedures codes from physician billing claims data to study injury (including HI) among children. In particular, one could determine with relative confidence the number of children who receive medical care for an HI, where they receive this care, and the costs associated with ED visits for HI.

A number of limitations should be considered in the interpretation of the results. This study involved data for children in Montreal, Quebec and the results may not be generalizable to older populations or to those in other regions. Ideally, sensitivity and specificity estimates require that subjects be classified into diagnostic groups using an error-free gold standard. As discussed above, misclassification within the gold standard could have occurred.

In Quebec, where fee-for-service billing is the predominant method of remuneration, the combination of diagnostic and procedures codes in a physician claims database may be a valid method of estimating injury occurrence among children. Its use may however lead to an underestimation of the frequency of visits for HI, particularly in younger children.

4.1.8 Ethics approval

This study was approved by the Montreal Children's Hospital Research Ethics Board of the McGill University Health Center and the ethics committee of the Centre de recherche, Hôpital Sainte-Justine.

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CHAPTER 5: GENERAL DISCUSSION

The specific results of this research have been discussed in detail in the published article presented in Chapter 4. The present chapter will therefore include a general discussion of the results with an emphasis on the potential uses of RAMQ data to study HI or injury among children in Quebec.

We compared childhood injury diagnoses using CHIRPP data with that from a RAMQ database for the same group of children who visited an ED for the same index injury. The concordance between the two data sources was 'substantial' and the sensitivity and specificity of claims data were found to be acceptable for identifying HI and MSK injury. Analyses of discordant pairs among the physician claims data and that from the surveillance system suggested that the reasons for disagreement varied and some were more easily accounted for than others. Specially, among 581 discordant pairs, 52% (n=304) were billed with the diagnostic code "multiple unspecified wound or trauma" and 95% of these were classified by CHIRPP as HI or Probable HI. Another 18% of cases (n=107) were billed with a diagnosis unrelated to injury (e.g. sinusitis, chicken pox) yet 96 % of these had HI or probable HI CHIRPP based diagnoses. These coding errors may be due to lack of formal medical training of medical records personnel in the identification of the diagnostic and procedure codes related to HI. Or, physicians may simply have focused on the immediate medical problem (e.g. fracture, chicken pox) and neglected to document that the child had a concomitant HI. We believe that these errors lead to an underestimation of the occurrence of HI in the RAMQ database. Moreover, physicians may not be able to confirm a diagnosis of HI in an injured child during a single medical encounter for multiple injuries; children may not complain of HI related symptoms unless they are asked about them. All physicians, regardless of their place of work, should be made aware of the possible symptoms and long-term consequences (e.g. persistent headache, pain, fatigue, vision or hearing problems, memory problems, confusion, sleep disturbances, or mood changes) of HI, as well as of the important number of children with HI. To further improve the recording of a HI diagnosis in physician claims, individuals need to be better trained for recording this type of diagnosis. If physicians pay more attention to this type of injury, perhaps they will be more attentive in their RAMQ or CHIRPP recording of HI. Ideally, the results of our study should be shared with physicians directly to remind them of the importance of quality data about childhood injury.

The findings of this study are important because they suggest new applications and potential capabilities of using diagnostic and procedure codes from the RAMQ database to study injury (including HI) among children. Since the RAMQ database can identify HI and MSK encounters among children with relative accuracy and is population based (e.g. has near complete coverage of injuries requiring medical care), we believe that this database could be used to study the epidemiology of injuries in children in Quebec. In particular, one could use the RAMQ database to calculate the yearly incidence rates of HI among children, something that is currently unknown. However, since the ICD-9-CM codes, used in the RAMQ database, are a general purpose classification of diagnoses that do not incorporate an explicit severity dimension, one would be unable to estimate the incidence of the different levels of HI (mild, moderate, and severe). Recently developed software called ICDMAP that translates ICD-9-CM coded discharge diagnoses into an Abbreviated Injury Scale (AIS) score may be helpful in this regard. AIS score is a specialised trauma classification of injuries based mainly on anatomical descriptors of the tissue damage caused by the injury (6). ICDMAP has been validated and shown to be useful in categorising the severity of injuries when only ICD rubrics are available (20) (64) (65) (76). It could be interesting to test the application of this new approach with the RAMQ database, and then use a concurrent CHIRPP database or medical files to validate this approach for HI among children.

The RAMQ database could also be used to estimate the costs of health care associated with medical visits for injury and follow-up among children. This information is important because health costs are often a more understandable measure of the magnitude of an injury problem than incidence (72). In other words, cost of injury studies could translate the adverse effects of injuries into dollar terms, the universal language of decision and policy makers. Estimates of the magnitude of the injury in financial terms can be used to justify intervention programs, and assist in the allocation of research dollars on specific injury type (e.g. HI). Policy makers could identify "high cost" injuries (compared with other injuries) and make these injuries a priority for rehabilitation interventions and prevention programs.

Children with HI however require multidisciplinary medical and rehabilitation services provided by physiotherapists, occupation therapists, and social workers etc. Unfortunately, the RAMQ database is limited to physician records on the diagnosis and the costs of medical services provided. Information about the treatment and costs of rehabilitation services received by children with HI is lacking in part because databases for physiotherapy or occupational therapy do not exist in Canada. Therefore, we cannot obtain a complete picture about the costs of health care associated with medical visits for HI among children based solely upon physician claims data.

The RAMQ database could also be used to describe places of treatment and medical specialists seen by children seeking care for injury. Information identifying the high users of medical services, the places of treatment and who sees the children, may help to ensure appropriate management of injury and prevention of subsequent injury. Kostylova and collaborators used the RAMQ database to describe the places of treatment and medical specialists seen by injured children who visited an ED for HI within the first 24 hours. These data were analysed according to the child's age, sex, and household income and compared to data for children who sought care for a MSK injury. Their results suggested that children with an HI receive medical care at similar places of treatment and by similar medical specialists as those seeking care for MSK injuries. Injured children most often visited physicians in primary health care, emergency medicine, paediatric and surgical disciplines for an injury suggesting that these physicians have an important role to play as advocates for childhood injury control and prevention of subsequent injuries (51). The RAMQ database has information on medical service. As such it may provide us with accurate data regarding service utilisation for persons with HI. This is important since knowing incidence of HI may help planning health services needs for rehabilitation.

Finally, given that the RAMQ database may be used to correctly identify children with HI and MSK injury in Quebec, we could follow (through interviews or using RAMQ data) children with these problems over time to determine different outcomes or future adverse events. For example, as part of my doctoral studies, I plan to use the RAMQ database to identify two groups of children (HI and MSK injury) and determine whether children with HI are at higher risk for suicide compared to children with MSK injury.

A number of limitations should be considered in the interpretation of our results. This study involved data for children who presented to an ED and completed a CHIRPP form and may be exclude severe cases of injury or HI (i.e. who bypassed the ED). Moreover, the results may not be generalised to older populations or those in other regions. Ideally, sensitivity and specificity estimates require that subjects be classified into diagnostic groups using an error-free gold standard. As discussed above, misclassification within the gold standard (CHIRPP) could have occurred. These advancements will help them better inform those with such injuries about available services such as health care, employment training, and personal assistance. Also a limitation of this study is the lack of an injury severity measure, since neither data source provided this information. Future ICD diagnostic codes could be improved to include a measure of HI severity based on a GCS score at admission.

Each database (CHIRPP and RAMQ) was developed for specific purposes and has its own strengths and weaknesses. Although CHIRPP provides important detailed information about injuries treated in an ED, one must keep in mind that the injury surveillance systems are not population based. This is in contrast to the physician claims database used in this study, which covers the continuum from ambulatory to hospital-based care, and provides information on almost all contacts with physicians in the health care system. Physician claims data are however limited to health care systems where fee-for-service payment is the predominant means of reimbursement. This is the case in Quebec and other parts of Canada, but it may differ in other countries where physicians are paid by capitation or salary.

Since there is no single best source for monitoring injury in a population I believe that it would be best to link several data sets (physician claims data with trauma registry or hospital data or medical files) to complement the unique strengths of each type of data set. By consulting multiple sources of information of injury we may be able to document this problem with greater accuracy in a more comprehensive manner.

CHAPTER 6: CONCLUSION

To our knowledge this is the first study that measures the accuracy of physician claims data against injury surveillance data for paediatric injury including HI. We believe this study demonstrates the potential capabilities of using diagnostic and procedure codes from physician billing claims data (RAMQ) to study injury including HI among children. In particular, one could determine with relative confidence the number of children who receive medical care for an HI, where they receive this care, and the costs associated with ED visits for HI.

Although the RAMQ database is lacking in details about the circumstances surrounding injuries, it may be particularly useful for describing the overall occurrence of injury at local or regional levels, and describing the economic implications of injury for the health care system. In Quebec, where fee-for-service billing is the predominant method of remuneration, the combination of diagnostic and procedures codes in a RAMQ database may be a valid method of estimating injury occurrence among children.

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APPENDIX I: Ethics Committee Approval Certificate

Centre universitaire de santé McGill
McGill University Health Centre

THE MONTREAL CHILDREN'S HOSPITAL
RESEARCH ETHICS BOARD

The Research Ethics Boards (REBs) of the McGill University Health Centre are registered REBs working under the published guidelines of the Tri-Council Policy Statement, the "Plan d'action ministériel en éthique de la recherche et en intégrité scientifique" (Ministère de la Santé et des Services sociaux, Gouvernement du Québec), and in compliance with standards set forth in the (US) Code of Federal Regulations governing human subjects research, and act in conformity with Good Clinical Practice: Consolidated Guideline (GCP E6).

A Montreal Children's Hospital Committee consisting of:

Jane McDonald, M.D., Chairperson	Microbiology
Gordon Watters, M.D., Co-chairperson	Neurology
Kathleen Glass, DCL, Co-chairperson	Ethicist/Lawyer
Laurel Kimoff, M.D.	Pediatrics
Sharon Vance	Community
Janet Rennick, Ph.D.	Nursing
Anne Usher	Community
Donald Meloche, L.Th.	Pastoral Services
Robert Barnes, M.D.	Endocrinology
Saleem Razack	PICU

reviewed on October 23rd, 2000 the research project entitled:

Risk of Subsequent Head Injury among Injured Children

submitted by: Dr. Bonnie Swaine

and consider it to be within acceptable limits of clinical investigation solely from the point of view of medical ethics. The following conditions apply to the ethical approval of the above-named study:

1. Receipt of scientific approval by the McGill University/Montreal Children's Hospital Research Institute.
2. Final approval of the IRB, i.e. the dated and signed IRB stamp on the French and English versions of the consent form will confirm scientific approval from the Research Institute.
3. If applicable, the contractual agreement must be signed by the appropriate authorities before the study can proceed.
4. The study is approved for a period of one year from the date shown below.
5. Prior to the end of the one-year period, the investigator(s) must advise the Institutional Review Board of the number and status of participants enroled in the study. We wish to be advised promptly of any significant adverse outcomes.
6. The investigator(s) must inform the Institutional Review Board should any changes be made to the study protocol and/or consent form.
7. Investigator(s) must notify the IRB of the starting date of the protocol and the date the [redacted]ves the right to examine your study data, including signed

[redacted]

Jan 31/01
Date

Jane McDonald, M.D., F.R.C.P©
Chairperson
Research Ethics Board

cc: Ms. Alison Burch, MCH Research Institute

L'HÔPITAL DE MONTRÉAL POUR ENFANTS • THE MONTREAL CHILDREN'S HOSPITAL
2300, rue Tupper, Montréal (Québec) H3H 1P3, Tél. (514) 934-4400

APPENDIX II: Canadian Hospitals injury Research and Prevention Program (CHIRPP) form

Hôpital Ste-Justine
Déclaration de blessure ou d'empoisonnement

- **Remplir seulement à la première visite relative à la présente blessure**
- **Fournir le plus de détails possible**
- **Écrire lisiblement en lettres moulées**

1 Quand la blessure est-elle survenue (p. ex , 13 h 00)? jour | mois | année

HEURE____________

1A. Date de la visite à cet hôpital (si différente) jour | mois | année

2. Endroit où s'est produit la blessure.

Domicile personnel (quel endroit ou pièce) ou la cour | Autre domicile (quel endroit ou pièce) ou la cour | Autre endroit (p. ex., magasin, école)

Sur la voie publique (p. ex., à l'angle du boulevard Saint-Laurent et de la rue Notre Dame)

3. Qu'est-ce que le blessé faisait au moment de la blessure (p. ex., jouait au hockey, traversait la rue, prenait un bain)?

4. La blessure est-elle survenue en faisant un travail rémunéré?

☐ Non ☐ Oui ➔ Genre de travail | Genre d'industrie ou d'entreprise

5. La blessure est-elle survenue pendant des activités récréatives ou sportives?

☐ Non ☐ Oui ➔ Si «Oui» ☐ organisées ☐ informelles ➔ Préciser ____________

6 Que s'est-il passé? (p. ex., un chien l'a poursuivi et il a perdu la maîtrise de sa bicyclette, son jouet s'est brisé, il a été éclaboussé par du café chaud)

7 Qu'est-ce qui a causé la blessure (p. ex., il a fait une chute sur le ciment, il s'est coupé sur son jouet, il a été brulé par du café chaud)

8. Énumérer tous les DISPOSITIFS DE SÉCURITÉ utilisés au moment de la blessure.

☐ Aucun ☐ Equipement de protection rembourré pour le sport ☐ Ceinture de sécurité ☐ Coussin gonflable

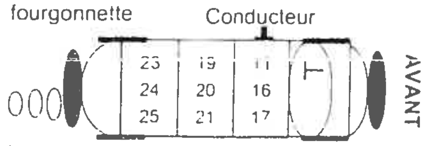
☐ Casque protecteur ☐ Bottes ou vêtements protecteurs ☐ Lunettes protectrices ☐ Siège d'auto pour enfant

☐ Autre dispositif de sécurité (préciser) ➔ ____________

9. Dans le cas d'une blessure en véhicule moteur, veuillez encercler le chiffre qui correspond à l'endroit où la personne était assise.

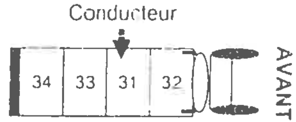
Voiture/camion/ fourgonnette

Conducteur



Motocyclette, motoneige, VTT

Conducteur



☐ Ailleurs que dans un siège ☐ Pendant le remorquage

10. LANGUE parlée le plus souvent à la maison du blessé?

NOUS DEVONS PARFOIS COMMUNIQUER AVEC LES PATIENTS (OU LES PARENTS) POUR OBTENIR PLUS DE DÉTAILS AU SUJET D'UNE BLESSURE - Si vous ne voulez pas être contacté, inscrivez un «X» ici ☐

IMPORTANT : REMETTRE CETTE FEUILLE AU MÉDECIN AU MOMENT DE LA CONSULTATION

HC/SC4006F/03 (05 2001)

PHYSICIAN'S INJURY SUMMARY

- Complete only for first attendance for this injury.
- Please check that the front of the form is complete.

Physician's Name ______________________

NATURE OF INJURY

- Select up to 3 codes

Most severe [|]

Second [|]

Third [|]

10 Superficial (e.g., bruise, abrasion)
11 Open wound/Laceration
12 Fracture
13 Dislocation
14 Sprain or strain
15 Injury to nerve
16 Injury to blood vessel
17 Injury to muscle or tendon
18 Crushing injury
19 Traumatic amputation

20 Burn or corrosion
21 Frostbite
22 Bite (with or without invenomation)
23 Electrical injury
24 Eye injury — use body part 135
25 Dental injury — use body part 135
26 Injury to internal organ

31 Foreign body in external eye — use body part 135
32 Foreign body in ear canal — use body part 135
33 Foreign body in nose — use body part 135
34 Foreign body in respiratory tract — use body part 135
35 Foreign body in alimentary tract
36 Foreign body in genito-urinary tract
37 Foreign body in soft tissue

41 Minor head injury — use body part 135
42 Concussion — use body part 135
43 Intracranial injury — use body part 135

50 Poisoning or toxic effect — use body part 900
51 Drowning or immersion — use body part 900
52 Asphyxia or other threat to breathing — use body part 900
53 Systemic over-exertion; heat/cold stress — use body part 900

60 Multiple injuries of more than one nature
70 No injury detected

N.B. For multiple system trauma (serious injuries of more than 3 types and body parts) use 60 + 700

Is substance use by the patient or other person suspected as a factor in this injury?

☐ No ☐ Yes ☐ Unknown

If Yes: ☐ Alcohol ☐ Other (specify) ______________________

2 BODY PART(S)

- Write the body part code for each of the injuries in NATURE OF INJURY at left.

Most severe [| |]

Second [| |]

Third [| |]

Head and Neck

110 Scalp, skull, head
120 Face (including ear)
130 Internal mouth
135 Specified head injury (specified by nature of injury)
140 Neck

Spine and Spinal Cord

200 Spine and/or spinal cord

Trunk

310 Thorax (incl. lungs, heart)
315 Upper back
321 Abdomen (incl. abdominal organs)
322 Lower back
323 Pelvis
324 Perineum and anogenital area

Shoulder and Arm

410 Shoulder
415 Clavicle
420 Upper arm
430 Elbow
440 Forearm
450 Wrist
460 Hand
470 Finger

Hip and Leg

510 Hip
520 Thigh
530 Knee
540 Lower Leg
550 Ankle
560 Foot
570 Toe

700 Multiple injuries of more than one body part
900 Body part NOT REQUIRED (e.g. systemic injury, no injury detected)

3 INTENT

- Select one code

[|]

10 Accident, injury was not intended
11 Intentional self harm
Sexual assault
13 Maltreatment by parent or caregiver
14 Maltreatment by spouse or partner
15 Other or unspecified assault
16 Event of undetermined intent

4 PATIENT DISPOSITION

- Select one code

[ ]

1 Left without being seen
2 Advice only
3 Treated, follow-up PRN
4 Treated, follow-up required
5 Short stay, observation in emergency
6 Admitted to this hospital
7 Transferred to another hospital (specify) ______________________
8 Dead on arrival or died in emergency

APPENDIX III : Demande d'autorisation à la Commission d'accès à l'information du Québec

Commission d'accès
à l'information
du Québec

Siège social
575, rue St-Amable, bureau 1.10
Québec (Québec) G1R 2G4
Téléphone : (418) 528-7741
Télécopieur : (418) 529-3102

Bureau de Montréal
2, Complexe Desjardins, Tour de l'Est, bureau 3210
B.P. 122, Succursale Desjardins, Montréal (Québec) H5B 1B2
Téléphone : (514) 282-0346
Télécopieur : (514) 844-6170

Québec, le 9 juillet 1999

Madame Bonnie R. Swaine, PhD
École de réadaptation
Université de Montréal
2815, boul. Édouard-Montpetit
C.P. 6128, succursale Centre-ville
Montréal (Québec) H3C 3J7

N/Réf. : 99 10 28

Madame,

Nous avons bien reçu votre demande d'autorisation d'obtenir, pour votre étude sur l'impact d'un traumatisme crânien au cours des 24 mois suivant le traumatisme, communication de renseignements nominatifs détenus par la Régie de l'assurance maladie du Québec (RAMQ), l'Hôpital Sainte-Justine et le Montreal Children's Hospital.

Dans un premier temps, afin d'identifier la clientèle devant faire l'objet de votre étude, vous devez demander l'autorisation aux directeurs des services professionnels de l'Hôpital Sainte-Justine et du Montreal Children's Hospital en vue d'obtenir les renseignements relatifs aux enfants d'un mois à 18 ans ayant subi un traumatisme et reçu des soins au centre de traumatologie de ces deux établissements.

Nous comprenons que les fichiers créés par les deux établissements de santé seront acheminés directement au service des statistiques de la RAMQ.

Dans un deuxième temps, nous avons analysé votre demande relative aux services médicaux reçus par cette clientèle et nous vous autorisons, conformément à l'article 125 de la *Loi sur l'accès aux documents des organismes publics et sur la protection des renseignements personnels*, à recevoir de la RAMQ les renseignements suivants :

- le numéro d'assurance maladie (brouillé);
- l'âge;
- le sexe;
- les trois premières positions du code postal;
- la date de l'acte;
- le code de l'acte;
- le lieu de dispensation (catégorie seulement);

- le code de diagnostic;
- le montant payé;
- le code M22 du lieu du service.

Ces renseignements concerneront les enfants âgés d'un mois à 18 ans ayant subi un traumatisme entre le 1er janvier 1998 et le 31 décembre 1999 et qui ont été traités à l'Hôpital Sainte-Justine et au Montreal Children's Hospital. La période couverte par ces informations sera de 24 mois suivant le traumatisme.

Cette autorisation est cependant assortie des conditions suivantes que vous devez respecter :

- vous devez assurer la confidentialité des renseignements nominatifs que vous recevrez;

- vous devez faire signer un engagement à la confidentialité aux membres de l'équipe de recherche qui n'ont pas signé le formulaire de demande d'autorisation et à toute autre personne qui s'ajoutera, par la suite, à cette équipe;

- vous devez utiliser les renseignements reçus uniquement pour cette recherche particulière;

- dans vos rapports, vous ne devez pas publier un renseignement permettant d'identifier un individu;

- vous ne devez pas communiquer un renseignement reçu à d'autres personnes que celles qui sont autorisées à le recevoir dans le cadre de cette recherche;

- vous devez détruire les renseignements au plus tard le 30 juin de l'an 2002.

Enfin, il est opportun de vous rappeler que la décision ultime de vous communiquer ou non ces renseignements nominatifs appartient toujours à l'organisme détenteur, en l'occurrence la RAMQ.

Veuillez agréer, Madame, l'expression de nos sentiments les meilleurs.

Le directeur de l'analyse
et de l'évaluation par intérim,

[redacted]

RP/MC/lp

Robert Parent

c.c. Mme Huguette Lefèvre, RAMQ

Régie de
l'assurance maladie
du Québec

Case postale 6600
Québec (Québec)
G1K 7T3

Service de la production et de la
diffusion de l'information
Téléphone (418) 682-5163
Télécopieur (418) 643-7381

Le 26 février 2002

Docteur Bonnie Swaine
Professeure adjointe
Centre de recherche
Institut de réadaptation de Montréal
6300, Darlington, 4[ième] étage
Montréal (Québec)
H3S 2J4

[redacted]

Docteur,

Vous trouverez ci-inclus les données demandées sur les patients participants à votre étude. Donc, pour chacun des NAM fournis, nous avons extrait les services médicaux pour une période d'un an après leurs dates d'accident. Je joins également la fiche de description des fichiers ainsi que la liste de valeurs de certains champs les formant.

La Direction des ressources financières vous fera parvenir une facture au montant de 1 000 $ (taxes non incluses).

Si des informations supplémentaires étaient nécessaires, n'hésitez pas à me contacter.

Espérant le tout à votre entière satisfaction, je vous prie d'agréer, Docteur, l'expression de mes sentiments distingués.

[redacted]
Simon Veilleux
Service de la production et de la
diffusion de l'information

SV/cm

p.j.

c.c. - M. Jacques Barry

APPENDIX IV: Poster presented to the 7th World Conference on injury Prevention and Safety Promotion, Vienna, June 2004

Introduction

- The injury surveillance system called the Children's Hospitals Injury Research and Prevention Program (CHIRPP) is a primary source of information on patterns of childhood injury in Canada
- Physician billing claims represent another data source for injury research

  Besides the exploratory work of Taylor and colleagues (1999), to our knowledge the use of this data has never been formally validated for paediatric injury

  The Régie de l'assurance maladie du Québec (RAMQ) – the government agency responsible for administering the provincial health insurance plan was however shown to provide a valid source of information for outcome assessment of injuries in the elderly (Tamblyn et al 2000)

Objectives

- To compare data gathered using an injury surveillance system (i.e. CHIRPP) with that from a physician billing claims database (i.e. RAMQ) for the same group of children who visited an emergency department for the same index injury
- To determine the concordance and proportion of overall agreement between the injury diagnoses (Head Injury (HI), Probable HI or Orthopaedic Injury),
- To determine the sensitivity and specificity of diagnostic and procedure codes in billing claims for identifying HI and Orthopaedic injury for children

Methods

Two data sources

CHIRPP data include

- Information about the circumstances of the injury
- Physician recorded clinical information diagnoses injured body part and treatment provided
- Child's personal health insurance number date of birth sex postal code
- Date of visit for index injury

RAMQ data include

- Physician identification number
- Type of consultation
- ICD9-CM diagnostic codes
- Procedures codes and procedure costs
- Child's personal health insurance number
- Date of visit for index injury

Procedure

CHIRPP diagnostic codes for 3145 children (1-18 yrs) who sought care from 12/2000 to 10/2001 were used to separate the children into three groups (HI, Probable HI and ORTHO)

Children with a HI (e.g. skull fracture, minor head injury, concussion, intracranial injury and multiple injury with associated head injuries) → HI Group

Children with injuries to the eyes, facial fractures, dental injuries or facial lacerations only, when accompanied with one of the mechanisms of injury: struck forcefully against a hard surface, a fall from a height or both → Probable HI Group

Children with an orthopaedic injury of the upper or lower extremity (e.g. fracture, sprain, dislocation) → ORTHO Group

File containing these data (3 groups) was sent to the RAMQ

Procedure

RAMQ provided the complete registry of services paid to physicians for 3049 children (12m post index injury). An algorithm classified the children into the same three groups, using ICD9-CM diagnostic and procedures codes from the physician claims database

Children who received health services for a HI (ICD9-CM codes 800, 801, 803, 804, 850-8549, 9083 or procedure codes specific to HI 7500-7507, 7535-7598) → HI Group

Children who had a combination of the following diagnostic (ICD9-CM 802, 830, 873, 910, 920, 959) and procedure codes (1320, 2113, 2505 2527, 8010 8030 8258 59, 8570) or either one of these codes → Probable HI Group

Children who received health services for an injury to the upper and lower extremities (ICD9-CM 810-819, 820-829, 831-839) → ORTHO Group

ICD9-CM diagnostic codes

[illegible]

Procedures codes

[illegible]

Analysis

- A 3X3 table was created to calculate the percent overall agreement and a weighted Kappa to estimated the agreement between the two data sources
- Using CHIRPP as the gold standard, sensitivity and specificity for HI and orthopaedic injury were calculated using a 2 X 2 table where the HI group was combined with the Probable HI group and compared to the Orthopaedic group

Word table of sample characteristics

Results

Percent agreement	81 %	581 discordant pairs
Weighted Kappa	0 66	95% CI 0 63-0 69
Sensitivity for identifying		
HI	0 61	95% CI 0 57-0 64
Orthopaedic injury	0 97	95% CI 0 96-0 98
Specificity for identifying		
HI	0 97	95% CI 0 96-0 98
Orthopaedic injury	0 58	95% CI 0 56 0 63

* Mean age of children in discordant pairs (6 6 yrs) < mean age of rest of sample (8 5 yrs) p< 001

Discordant pairs

Reasons for discordance	Frequency	%
Billed with diagnostic code multiple unspecified wound or trauma N B 55 (n= 289) were classified by CHIRPP as HI or Probable HI	304	52
Billed with diagnostic codes indicating HI or Probable HI N B 41% were classified by CHIRPP as Ortho	99	17
Billed with as having an UE or LE fracture	44	8
Billed with a diagnosis unrelated to injury (e g viral infection, sinusitis, chicken pox)	107	18
Billed with a diagnosis possibly related to HI (e g nausea, headache)	11	2
Lacked a procedure or a diagnostic code in claims database precluding classification as a HI or probable HI	16	3

Discussion

- This study demonstrates a new application and the potential capabilities of using diagnostic and procedures codes from physician billing claims data to study injury including HI in children
- Concordance is substantial between childhood diagnoses for HI, Probable HI and Orthopaedic injury recorded on an injury surveillance tool and those derived from a physician claims database
- The sensitivity of claims data varies by injury type and identifying orthopaedic injury is more successful than identifying HI

Discussion

Possible reasons for the less than optimal level of concordance between data sources and sensitivity for HI include

- High frequency of use of non specific diagnostic codes in physician billings
- Coding errors completing RAMQ reimbursement forms (i e children who completed a CHIRPP form for an injury were billed with a RAMQ diagnostic code other than trauma)
- Recording errors of injuries using the CHIRPP system

Conclusion

- In Quebec, where fee-for-service billing is the predominant method of renumeration, the combination of diagnostic and procedures codes in a physician claims database may be a valid method of estimating injury occurence among children
- Its use may however lead to an underestimation (of about 10%) of the frequency of visits for head injury particularly in younger children

References

Mackenzie SG, Pless IB. CHIRPP: Canada's principal injury surveillance program. Inj Prev 1999 5 208 213
Tamblyn R, et al. Using medical services claims to assess injuries in the elderly: sensitivity of diagnostic and procedure codes for injury ascertainment. Am J Epidemiol 2000 53 183-194
Taylor B, et al. Trauma recurrence in the pediatric population. J Trauma 1999 46 475 482

Acknowledgments

This study is funded by the Canadian Institutes of Health Research

APPENDIX V: Abstract presented to The American Congress of Rehabilitation Medicine, 2005 ACRM-ASNR Joint Conference, Chigago, September, 2005

Title:	**Places of treatment and medical specialists seen surrounding children's visits to an emergency department for a head injury.**
Authors & affiliations:	**Alla Kostylova, PT, Bonnie Swaine PT, PhD, Debbie Feldman, PT, PhD.** School of rehabilitation, Université de Montréal; Center for interdisciplinary rehabilitation research, Qc, Canada
Abstract:	**Objectives:** Describe places of treatment and medical specialists seen by children who visited an emergency department (ED) for head injury (HI) according to child's age, sex, and household income and compare the results to children who sought care for a musculoskeletal injury. **Design**: Cohort study. **Setting**: Montreal. **Participants**. 3049 children visited ED for injury at one of two tertiary care paediatric hospitals (mean age = 8 yr., 61% males, average household income $40462); 1147 for a HI and 1902 for a musculoskeletal injury. **Intervention**: None. **Main Outcome Measures**: Place of treatment and type of physicians seen within 24 hours surrounding the ED visit. **Results**: Besides their ED visit, 8% of children with HI visited a physician's office. They received treatment from 1-6 (mean 1.2) different physicians and had fewer claims than those with musculoskeletal injury (1.5 per child vs. 2.2; $p < .001$). Children with a HI aged 5 - 9 years and those from families with higher household incomes tended to see the most specialists. **Conclusion**: Prevention strategies aimed at reducing subsequent HI should consider that children with HI receive care from several specialists in different facilities. **Key words**: Head Injury, Rehabilitation, Medical Specialty

APPENDIX VI: Co-authors Accord

SIGNATURE DES COAUTEURS

À faire parvenir **par courrier à**

TGDE – Programme de Sciences
biomédicales 2e et 3e cycles
Faculté de médecine
Pavillon Roger-Gaudry
Bureau P 710 M.Sc. P 709 Ph.D.
C.P. 6128, succursale Centre-ville
Montréal, Qc
H3C 3J7

ou par **fax au 343-5751**

Titre du 1er article :

CONCORDANCE BETWEEN CHILDHOOD INJURY DIAGNOSES FROM TWO SOURCES : AN INJURY SURVEILLANCE SYSTEM AND A PHYSICIAN BILLING CLAIMS DATABASE

Signature des coauteurs :

Nom [redacted]

Etc...

BONNIE SWAINE
DEBBIE FELDMAN