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Health care access and injury patterns in patients following moose– and deer–vehicle collisions in north-central British Columbia

An analysis of emergency department admissions indicates the time of year that doctors may need to attend to patients involved in moose– and deer–vehicle collisions, what types of injuries they may receive, and what treatments they may require.

ABSTRACT

Background: Moose–vehicle collisions and deer–vehicle collisions are dangerous and costly. Motorists are sometimes killed in such encounters but more often sustain injuries ranging from minor to severe. Reports of how patients of such collisions in British Columbia arrive at hospitals, the types of injuries they sustain, and the kinds of immediate and follow-up treatments they receive have not been published.

Methods: We examined hospital records of 183 patients injured in vehicle collisions with deer and moose in north-central BC between 1993 and 2014. Data analyzed included the month of collision occurrence, the number of patients transported to the emergency department via ambulance versus the number of walk-ins, the types of injuries incurred, the duration of hospital stay, and the main types of treatment interventions required: pain management, imaging, and additional interventions of a particular medical specialty.

Results: Hospital records suggested differences in seasonal patterns of moose– and deer–vehicle collisions, and in patient outcomes. Collisions with deer and moose occurred most often in August and September, respectively. Patients involved in moose–vehicle collisions had more serious injury types, received more extensive treatments, and required wider varieties of medical specialties for treatment than those involved in deer–vehicle collisions.

Conclusions: This study provides emergency responders and doctors with the information they need regarding when to expect to attend to patients of moose– and deer–vehicle collisions, what types of injuries they can incur, and what treatments they may require.

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Background

In North America, motor vehicle collisions with wildlife (wildlife–vehicle collisions) have increased with increased vehicular traffic, and in Canada, result in approximately 45 000 reported wildlife–vehicle collisions each year.[1,2] However, the actual number of wildlife–vehicle collisions is likely much higher due to underreporting of collisions.[3-6] It is estimated that in Northern BC, 55% to 65% of both deer–vehicle collisions and moose–vehicle collisions go unreported.[4] Road, automobile, and wildlife densities all influence collision occurrence.[2,7]

Many roads in north-central British Columbia wind through mountainous wilderness terrain and boreal forests where animals move between seasonal ranges or use roadside habitats. Dozens of wildlife species are hit and killed by vehicles on BC roads, but the most common large mammals involved are moose (*Alces alces*), mule deer (*Odocoileus hemionus hemionus*), white-tailed deer (*Odocoileus virginianus*), and black-tailed deer (*Odocoileus hemionus columbianus* and *Odocoileus hemionus sitkensis*).[8-10]

In BC, deer–vehicle collisions outnumber moose–vehicle collisions by 3 to 1.[11] Although there are fewer collisions with moose, their size and high centre of gravity make them particularly dangerous in a vehicle collision **[Figure 1]**. Deer are much smaller than moose; therefore, they generally cause less damage to vehicles and fewer injuries to motorists when struck by vehicles.

From 2000 to 2014, there were 236 deaths in Canada due to moose–vehicle collisions and 123 deaths due to deer–vehicle collisions.[12] However, injuries are far more common than fatalities, with most injuries ranging from manageable to traumatic.[12,13]

From 2016 to 2020 in Northern BC, there were an average of 2700 wildlife–vehicle collisions, 210 injured victims, and 2 deaths per year.[14] Data from the Insurance Corporation of British Columbia (ICBC) for Northern BC indicate that numbers of moose–vehicle collisions peak in December and January, whereas numbers for deer–vehicle collisions peak in October and November.[11]

Pynn and Pynn[15] studied injury patterns and management in patients involved in motor vehicle collisions with large animals and summarized current prevention strategies. They found moose–vehicle collisions led to a higher number of upper body injuries, specifically to the head, due to the mechanism of the collision. When a vehicle strikes a moose, the point of contact is usually the moose's legs; thus, the torso of the moose often lands on the hood of the car and slides up and through the windshield and across the dashboard of the car, coming in contact with the upper body of the motorists.[15,16]

Although Pynn and Pynn[15] mentioned initial stabilization (treatment given when ambulances reach the crash scene) in patients involved in moose–vehicle collisions, it was available only for those who had suffered traumatic injuries in the collision. Overall, there is a paucity of published records on what happens to patients if and when they first visit an emergency room in the hours following a collision.

We examined injury and treatment patterns in patients involved in moose–vehicle collisions and deer–vehicle collisions, starting with the initial visit to the emergency room at the University Hospital of Northern British Columbia (UHNBC) in Prince George, BC.

FIGURE 1. Types of vehicle damages and risks to motorists sustained during a moose–vehicle collision (4 July 2014; permission of the Annance family).

Our objective was to elucidate injury patterns in patients following either a moose–vehicle collision or a deer–vehicle collision and to provide information to doctors and emergency responders on these patterns.

Methods

We examined UHNBC records for patients involved in moose–vehicle collisions and deer–vehicle collisions between 1993 and 2014. The records were redacted to remove identifying or confidential information before analyses were conducted. There were 183 records of motor vehicle collisions with moose and deer, of which 129 were direct collisions with moose and 27 were direct collisions with deer. We excluded 27 records of collisions that were the result of impacts with other objects (tree, ditch, etc.) when the driver attempted to avoid colliding with a moose or deer. The experiment was approved by the University of Northern British Columbia Research Ethics Board under research ethics application approval # 2013.08.01.E2013.0619.078.00.

Data were analyzed using the chi-square test to compare sets of observed and adjusted frequencies with sets of expected or predicted frequencies.[17] Our statistical methodology is available upon request.

To avoid underestimating the impact of deer–vehicle collisions and erroneously comparing the entire spectrum of moose–vehicle collisions (ranging from minor to severe) to only a few of the most severe deer–vehicle collisions, we applied the 3-to-1 ratio[11] to derive a calculated deer–vehicle collision value, and used that corrected value in the analysis. Specifically, if 129 moose–vehicle collisions caused patients to seek medical help, there would have been 3 times as many deer–vehicle collisions as moose–vehicle collisions (3 × 129 = 387) in the same time span and study area. Analyzing these data in this way provided a better real-world statistical comparison in terms of the number of deer being struck by cars but may have overestimated the overall damage caused by the average deer–vehicle collision. From a practical perspective, however, medical professionals preparing for the reception of a patient involved in a deer–vehicle collision will be better prepared for a worst-case scenario.

Data on the main interventions used to treat patients upon arrival at the emergency department were analyzed according to four

categories: pain management (administration of medication or physiotherapy), imaging (CT, MRI, X-ray), additional interventions of a particular medical specialty, and no treatment.

Results

Of the 156 hospital records examined, 53% of patients involved in moose–vehicle collisions or deer–vehicle collisions were transported to the UHNBC emergency department via ambulance, whereas 47% were walk-ins. Significantly more patients ($P < 0.001$) involved in moose–vehicle collisions arrived at the emergency department via ambulance (57%) than those involved in deer–vehicle collisions (41%). Forty-three percent of patients involved in moose–vehicle collisions were walk-ins; 59% of patients involved in deer–vehicle collisions were walk-ins.

In moose–vehicle collisions, 55% of injuries were below the neck, and 45% of injuries were to the neck and/or head. In deer–vehicle collisions, 63% of injuries were below the neck; 37% were injuries to the neck and/or head.

For patients of moose-vehicle collisions, 59% suffered traumatic brain injury; for deer-vehicle collisions, 41% suffered traumatic brain injury. Additionally, there was a significant difference in airbag deployment between moose–vehicle collisions (79%) and deer–vehicle collisions (56%) ($P < 0.001$).

Overall, records for both moose–vehicle collisions and deer–vehicle collisions indicated that most patients were admitted and discharged from the hospital on the same day. Patients admitted to the emergency department due to moose–vehicle collisions received approximately equal treatment within three of the four categories of interventions: pain management, imaging, and medical specialty. Patients admitted due to deer–vehicle collisions had more use of pain management and imaging, and less use of other medical specialties. Overall, more additional types of treatment were required for patients of moose–vehicle collisions than those of deer–vehicle collisions.

In patients of deer–vehicle collisions, 93% were treated in the emergency department without additional need of other medical specialties, while the remaining 7% required orthopaedic surgery. Most moose–vehicle collision patients (81%) were treated in the emergency department without additional medical specialties required. Significantly more moose–vehicle collision patients (26%) than deer–vehicle collision patients (8%) required multiple specialties ($P < 0.05$), with orthopaedic surgery being most common.

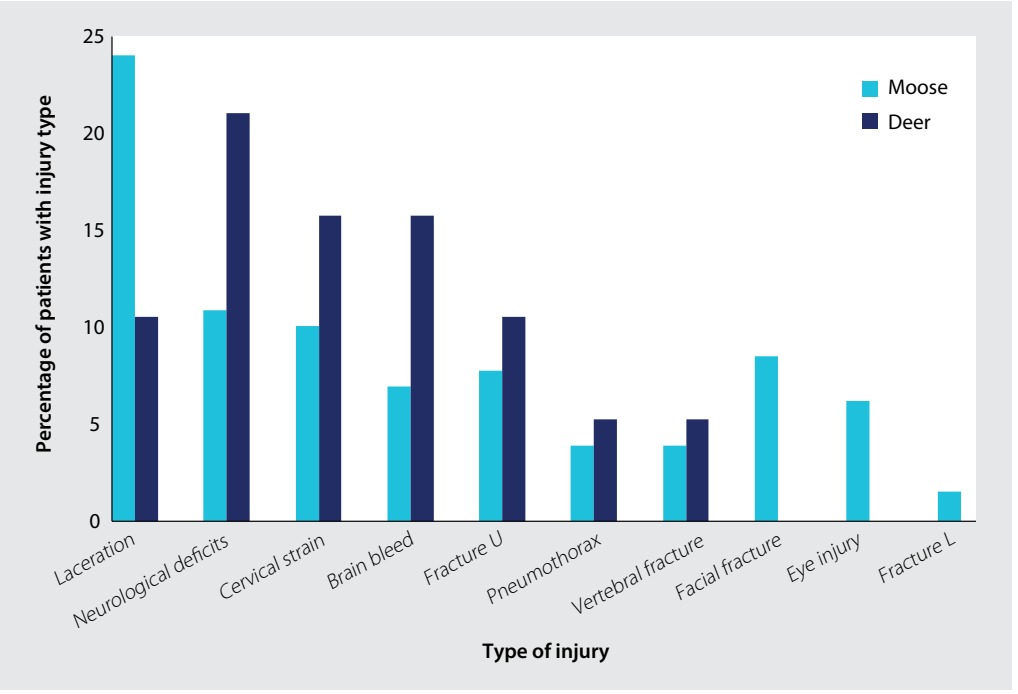

FIGURE 2. Injuries in patients who were involved in moose– or deer–vehicle collisions and were admitted to the University Hospital of Northern British Columbia, 1993–2014.
Fracture U = upper body fracture; Fracture L = lower body fracture.

Further trends in injury patterns were significantly different between patients of moose–vehicle collisions and deer–vehicle collisions **[Figure 2]**. While lacerations were most common in moose–vehicle collision patients, neurological deficits were most common in deer–vehicle collision patients. Moose–vehicle collision patients had significantly more types of injuries not seen in deer–vehicle collision patients, such as facial fractures, eye injuries, and lower body fractures ($P < 0.01$).

Our analysis suggests that August was the month with the highest percentage of deer–vehicle collisions (25%), while September was the month with the highest percentage of moose–vehicle collisions (17%). Other peak months for both moose–vehicle collisions and deer–vehicle collisions were June and December.

Conclusions

Our findings demonstrated that compared with deer–vehicle collisions, moose–vehicle collisions significantly increase both the probability of airbag deployment and the number of patients arriving by ambulance at the hospital. This is perhaps because moose–vehicle collisions result in significantly more deceleration trauma to vehicle occupants compared with deer–vehicle collisions because of the animal's size, high centre of gravity, overall mass, and trajectory.[18]

Our results also revealed a characteristic pattern of both neck and/or head injuries and below-neck injuries in patients of moose– and deer–vehicle collisions. Specifically, our moose–vehicle collision data corroborate work by Sit and colleagues,[19] who reported a characteristic pattern of head and neck injuries in patients involved in moose–vehicle collisions and deer–vehicle collisions. Understanding the prevalence of these patterns adds to reports by Pynn and Pynn[15] and may help with the prevention of injuries and emergency care requirements of patients following motor vehicle collisions with large animals.

Although our hospital stay data showed similarities in same-day discharges between moose–vehicle collision and deer–vehicle collision patients, the interventions used to treat patients upon hospital admittance were different between the two groups. Patients who suffered injuries from moose–vehicle collisions required significantly more extensive treatment than those who were injured in deer–vehicle collisions. Conway and colleagues[13] reported that differences in injuries experienced by patients whose vehicles collided with deer versus moose can be both short-term and long-lasting.

Although patients involved in deer–vehicle collisions had a higher percentage use of medical imaging than those involved in moose–vehicle collisions, only 7% needed additional medical specialty treatment. This could mean that for most patients who required medical imaging, its use may have been for precautionary reasons. In comparison, 27% of moose–vehicle collision patients required significantly more treatment from an additional medical specialty, the most common being orthopaedic surgery. This difference in injury severity between patients of moose–vehicle collisions and deer–vehicle collisions is likely due to differences in the overall mass and centre of gravity of moose and deer **[Figure 3].**

As outlined by Bjornstig and colleagues[16] and Pynn and Pynn,[15] vehicle collisions with moose can result in many upper body injuries to drivers and passengers due to the location of the vehicle's impact with the moose's body. Vehicles typically hit the legs of the animal. This results in the heavy upper body of the moose falling with high velocity on the vehicle's windshield, which can cause significant damage to the windshield and roof pillars and the vehicle occupants[15,16,19] **[Figure 1]**. The mechanism of vehicle collision with deer is similar to that of moose, but the smaller stature and overall mass of deer generally results in less and lower damage to the vehicle and less injury to vehicle occupants, which is likely why there are fewer hospital records for these types of collisions.[7] Differences between moose– and deer–vehicle collisions in what happens upon impact may reveal why we found that facial fractures, eye injuries, and some lower body fractures were documented for moose–vehicle collisions but not for deer–vehicle collisions.

There was a significant statistical interaction between the percentage of patients with lacerations and those with neurological deficits. Patients of moose–vehicle collisions had more lacerations and fewer neurological deficits than patients of deer–vehicle collisions. This may be due to the principal point of vehicle contact with the animal **[Figure 3]**. Damage in moose–vehicle collisions occurs primarily at the windshield, whereas in deer–vehicle collisions, the impact tends to occur lower down on the vehicle at the bumper or grill. In moose–vehicle collisions, damage to windshields results in increased head and neck injuries, and lacerations caused by shattered windshield glass. In deer–vehicle collisions, the lower impact location on the front of the vehicle may result in injuries such as whiplash, which may explain the higher likelihood of neurological deficits in these types of collisions.

Monthly collision trends showed that numbers of moose–vehicle collisions and deer–vehicle collisions begin to increase in May and show a small peak in June. The main peak in moose–vehicle collisions occurs in September, whereas the main peak for deer–vehicle collisions occurs in August. Our findings generally support the work of Laurian and colleagues,[20] who found that there were two peaks in the number of road crossings by moose on highways and forest roads, corresponding to May through July and September through October. Peak collision seasons vary by species and location and are generally attributed to changes in animal behavior and ecology, such as movements between seasonal ranges or use of roadside habitats, but may also be tied to other factors.[2,21-23]

Driver behavior and road conditions also influence trends in moose– and deer–vehicle collisions. From May to October, road conditions are generally good, and there are long hours of daylight. As a result, drivers may exceed speed limits, which increases the risk of both moose–vehicle collisions[24] and deer–vehicle collisions.[25] The number of human deaths due to motor vehicle crashes is highest from May to October.[26] Weather conditions begin to worsen in November. More snow and fewer daylight hours lead to more hazardous road conditions, lower driving speeds, and perhaps fewer injuries

FIGURE 3. Typical principal points of contact between animals and vehicles following moose–vehicle collisions (A; 6 July 2005) and deer–vehicle collisions (B; 2 January 2015).

or deaths due to vehicle collisions with moose or deer.

We found differences in the seasonal patterns of moose–vehicle collisions and deer–vehicle collisions when comparing hospital patient records to vehicle collision records from ICBC.[11] Our hospital records appeared to indicate that when factoring in the 3-to-1 ratio of deer–vehicle collisions to moose–vehicle collisions and then pooling hospitalizations due to both deer– and moose–vehicle collisions, September was the month with the third-highest number of collisions resulting in injury but was the month with the lowest number of collisions reported to ICBC. November was among the months with the lowest number of collisions reported in the hospital records but was among those with the highest number of collisions in the ICBC records. Differences in seasonal peaks in collisions between the two databases may be attributable to several factors, including the fact that only 156 collision records in this study were

compared with more than 1800 collision records reported to ICBC and analyzed,[11] and the two databases included different types of data (i.e., vehicle collision data reported to ICBC versus patient data collected at the hospital).

Although time of day of the collision was not recorded in the hospital records, O'Keefe and Rea[11] and Vanlaar and colleagues[12] reported that most collisions with moose and deer occur at night, when animals are most difficult to see. Reduced visibility and driver detection time of moose[24] and deer[27] during hours of darkness can result in reduced warning and braking time, and a higher likelihood of collision. Emergency responders and doctors should be aware of this, and we recommend that in the future, the time of collision be recorded in hospital records where possible.

In summary, the hospital records of patients involved in moose– and deer–vehicle collisions in north-central BC suggest that there is a significant relationship between moose–vehicle collisions and lacerations, and deer–vehicle collisions and neurological deficits. Also, our study shows that a wider variety of medical specialties are needed to treat patients who suffer injuries following moose–vehicle collisions than those injured in deer–vehicle collisions. It is our hope that by alerting the medical profession about when moose–vehicle collisions and deer–vehicle collisions are most common, how patients involved in those collisions sustain different kinds of injuries, and what types of services they require, emergency responders and doctors will have the information they need regarding when to expect to attend to patients of moose– and deer–vehicle collisions and what to expect in terms of their injuries and treatment. ■

Competing interests
None declared.

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Patients who suffered injuries from moose–vehicle collisions required significantly more extensive treatment than those who were injured in deer–vehicle collisions.

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