ADMISSION TO ACUTE HOSPITALS FOR INJURIES AS A RESULT OF ROAD TRAFFIC COLLISIONS IN IRELAND, 2005-2009

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ADMISSION TO ACUTE HOSPITALS FOR INJURIES AS A RESULT OF ROAD TRAFFIC COLLISIONS IN IRELAND, 2005-2009

Executive Summary

Introduction

The World Health Organization (WHO) cites that as many as 50 million people are injured or disabled in road traffic collisions (RTCs) each year. The Road Safety Authority (RSA) reported in 2008 that while road deaths were at the lowest level since records began in 1959; there was an increase in reported injury collisions in 2008. Internationally, statistics on injuries resulting from RTCs are under-estimated in many countries. The RSA acknowledges that this is also true for Ireland, despite increased efforts by An Garda Síochána to report on these injuries. To date, no other sources of data, for example, hospital attendances or insurance data have been published to provide information on the level of injuries. Consequently, the aims of this study were:

i. To profile and analyse trends in inpatient care in acute hospitals in Ireland for road traffic injuries for the years 2005-2009,
ii. To compare these data with data published by the RSA for 2005-2009 and,
iii. To profile trends in the ratio of hospitalised road users to fatally injured road users, 2005-2009, and
iv. To calculate the associated hospital costs for the years 2005-2008.

Methods

The RSA's definition of serious injury is an injury for which the person is detained in hospital as an inpatient, or any of the following injuries whether or not detained in hospital: fractures, concussion, internal injuries, crushings, severe cuts and lacerations, or severe general shock requiring medical treatment. For the purpose of this study, only those warranting hospital inpatient admission were studied as there is no national computer information system on those presenting to emergency departments (EDs) or general practitioners (GPs) with injuries resulting from RTCs.

Information on all patients who were discharged from acute hospitals in Ireland for the years 2005-2009, and who had been admitted as an emergency with a land transport injury (ICD-10-AM codes V01-V89), excluding non-traffic collisions and

unspecified collisions, were extracted from the Hospital In-Patient Enquiry (HIPE) system via Health Atlas Ireland. To calculate costs, diagnosis related groups (DRGs) for discharges for the years 2005-2008 were extracted.

Results

There were 14,861 hospital discharges of persons who had been admitted as inpatients on an emergency basis to Irish acute hospitals with an RTC-related injury during the five year period of 2005-2009. The number of discharges decreased from 3,080 in 2005 to 2,837 in 2009, representing a reduction of 243 (7.9%).

1. Profile of the Injured Persons

- Two-thirds (65%) of injured persons were male.
- The average age of those discharged from hospital with an RTC-related injury was 33 years. Almost half (43%) were aged less than 25 years.

2. Hospital Admission

- July and August were the two most common months for hospital admissions.
- Saturdays and Sundays were the most common days of admission.
- The mean length of inpatient hospital stay was 6 days, while the median length of stay was 2 days.
- The total number of bed days used by this group was 87,750 bed days. Therefore, during those five years, persons with RTC-related injuries occupied, on average, 48 beds a day in acute hospitals in Ireland.
- Over half (56%) of the injured persons had a length of stay of 1-2 days.
- 10% required admission to an Intensive Care Unit (ICU). The mean length of stay in ICU was 7 days, with a median length of stay of 3 days.
- The most common principal diagnoses recorded were head injuries (31%).
- Most commonly, principal procedures were carried out on the musculoskeletal system (40%).
- The majority of persons (87%) were discharged home from hospital. An additional 11% were transferred to another hospital, while 1% died in hospital.
- The average hospital inpatient cost for any RTC-related injury was € 6,395.

3. Trends 2005-2009

- The age standardised discharge rate/100,000 population for RTC-related injuries (excluding those who died within 30 days of admission), decreased significantly from 69/100,000 population in 2005 to 62/100,000 population in 2009.
- There was a downward trend in the discharge rates among car occupants, pedestrians and occupants of vans/trucks/pick-ups in the number of hospitalisations with RTC-related injury over the five years.
- The highest average age-standardised discharge rates/100,000 population was recorded among residents of counties Donegal and Roscommon, with rates in excess of 125/100,000 population.
- For the four year period of 2005-2008, inpatient hospital costs for RTC-related injuries increased by 12% from €18.1 million to €20.3 million.

4. Comparisons of Data

- There were 14,861 persons treated as inpatients in hospital with RTC-related injuries from 2005-2009. This number is 3.5 times greater than the number of serious injuries reported by the RSA using An Garda Síochána data (4,263).
- In particular, the number of cyclists injured is under-estimated in the RSA figures; with 1,050 cyclists admitted to hospital. However, over the same period, just 109 serious injuries among cyclists were reported by the RSA.
- The ratio of hospitalised road users to fatally injured road users in Ireland increased from 4.6 in 2005 to 7.0 in 2009. This Irish ratio compares favourably among OECD member countries with a low of three hospitalisations per fatality reported by Portugal and a high of 21 hospitalisations per fatality reported by the Czech Republic.

Discussion

This report presents, for the first time, information on the number of persons admitted to acute hospitals in Ireland following RTCs, with HIPE as the main data source. This study has identified a major under-reporting of serious injuries following RTCs. There were 14,861 persons treated as inpatients in hospital during 2005-2009 with RTC-related injuries. This number is 3.5 times greater than the number of serious injuries reported by the RSA using An Garda Síochána data (4,263). This finding is not surprising given that other countries have reported under-estimation in the numbers injured in RTCs. Research elsewhere has shown that multiple data sources provide a more accurate picture of the true extent of road injuries. Ideally information systems should be linked to get the best information, with personal identification codes for linking, if possible.

There are limitations to this study. No data were available from EDs, outpatient departments, private hospitals or from GPs. Due to the lack of a unique identification system, some repeat admissions and transfers may have been included.

This is the first national report on RTC-related injuries requiring hospitalisation in Ireland. The data are available through Health Atlas Ireland and should be reported on as a routine each year and be used in conjunction with An Garda Síochána and other data to provide more realistic and timely injury trends. Ideally, the information should be linked as in other countries; however, the lack of a unique identification system and data protection issues remain as obstacles to the linking of these data.

Introduction

The World Health Organization (WHO) reports that as many as 50 million people are injured or disabled in road traffic crashes (RTCs) worldwide each year, and that an additional 1.2 million people die as a result of their injuries [1]. The Road Collision Facts for 2008 published by the Road Safety Authority (RSA) reported that road deaths in Ireland were at the lowest level since records began in 1959; however, it noted that there was an increase in reported injury collisions in 2008, contrary to decreasing trends in recent years [2].

The current Road Safety Strategy 2007-2012 states: "that as per international evidence, statistics and facts on serious injuries from road collisions in Ireland are highly unreliable" [3]. Evidence attributes this to under-reporting despite increased efforts in recent years by both An Garda Síochána and the RSA to report on serious injury [3]. Despite this acknowledgment of under-estimation of the true burden of injuries, other possible sources of data, for example, numbers of hospital admissions and attendances at emergency departments (EDs), or insurance data, have not been developed to provide information on the level of injuries.

An examination of data and literature from other countries gives a clearer picture of the true extent of injury relating to RTCs, and suggests that other sources of information other than that collated by the police should be used to estimate the true numbers injured in RTCs. These other sources include cause of death statistics, as well as medical and insurance databases [4-9]. The literature also suggests that in particular, little is known of the financial cost of hospital inpatient care associated with RTC-related injuries [10, 11].

A remit of the Department of Public Health is to monitor and report on the health status of the population in the region and to study the determinants and distribution of factors that result in injury, illness and death. In addition this department has a particular interest in road safety, and has previously carried out extensive research on this subject [12-14]. Consequently, given the RSA's acknowledgement of possible under-estimation of the number of road injuries in Ireland, this Department sought to explore the possibility of using hospital data as an alternative source of injury data in Ireland.

In Ireland, no national data are reported on hospital admissions as a result of RTCs; consequently, the aims of this study were:

i. To profile and analyse trends in acute inpatient care in acute hospitals in Ireland for road traffic injuries over the five years of 2005-2009,
ii. To compare these data with the data published by the RSA for years 2005-2009,
iii. To profile trends in the ratio of hospitalised road users to fatally injured road users, 2005-2009, and
iv. To calculate hospital costs associated with these injuries for years 2005-2008.

Methods

The RSA's definition of serious injury is an injury for which the person is detained in hospital as an inpatient, or any of the following injuries whether or not detained in hospital: fractures, concussion, internal injuries, crushings, severe cuts and lacerations, or severe general shock requiring medical treatment [2]. For the purpose of this study, only those warranting hospital inpatient admission were studied as there is no national computer information system on those presenting to EDs or general practitioners (GPs) with injuries resulting from RTCs.

Data for this study were extracted from the Hospital In-Patient Enquiry (HIPE) system via Health Atlas Ireland. HIPE is a computer-based health information system that collects data on discharges from acute hospitals in Ireland.

Using HIPE, all discharges from acute hospitals in the Republic of Ireland for the years 2005-2009, and who had been admitted as an emergency and assigned any diagnosis codes V01-V89 (land transport accidents) using ICD-10-AM were extracted. All non-traffic collisions were excluded, that is those accidents that occurred entirely in any place other than a public highway, for example, V01.0– 'Pedestrian injured in collision with pedal cycle, nontraffic accident', as were unspecified collisions.

In order to estimate incidence, only one emergency admission per patient was extracted from the database, where possible. Due to the lack of unique identifiers, some repeat admissions may have been included if a patient was admitted to a different hospital and therefore given a different medical record number. In addition, a number of patients may have been coded as an emergency admission when transferred from another hospital, when they should have been coded as a transfer.

In order to calculate incidence rates, the number of emergency discharges of Irish persons from hospital for RTCs was used as numerator data and the total resident population in Ireland was used as denominator data. Total resident population data and county level data for 2006 were obtained from the Central Statistics Office of Ireland (CSO) [15]. National population estimates were also obtained from the CSO for the years 2005, 2007, 2008 and 2009 [16]. As county data are only available for 2006, to

calculate standardised rates for each county, the average number of discharges for each county over the five years was used as the numerator data and the population from Census 2006 was used as denominator data. Direct methods of standardisation were used to allow comparison of rates using the EU standard population as a comparison for national data, and using national population as comparison for county data. All rates were calculated using StatsDirect [17].

Costs for these RTC-related discharges were calculated using diagnosis related groups (DRGs) via Health Atlas Ireland for the years 2005-2008 only, as DRGs for 2009 were not finalised at the time of analysis.

In order to calculate the ratio of hospitalised road users to fatally injured road users, the number of discharges hospitalised for longer than one day with road injuries was compared to the number of fatally injured road users as reported by An Garda Síochána [18].

Data were analysed using JMP statistical package and statistical analysis was carried out using either the Chi-square test or Fishers exact test, where appropriate [19].

Hospital data for RTC-related injuries and RSA data for serious injuries were compared for the years 2005-2009 [2, 20-23].

Results:

Annual Number of RTC-related Hospital Discharges, 2005-2009

There were 14,861 hospital discharges of persons who had been admitted on an emergency basis to Irish acute hospitals with an RTC-related diagnosis during the five year period of 2005-2009. The annual number of discharges relating to road traffic injuries decreased from 3,080 in 2005 to 2,837 in 2009, representing a reduction of 243 (7.9%).

In total, for the years 2005-2009, HIPE reported almost 1.65 million discharges from Irish hospitals of persons who were admitted on an emergency basis. Discharges with RTC-related diagnoses account for approximately 0.9% of these discharges. Details of the total number of inpatient discharges and the proportion of these discharges that had RTC-related injuries, for the years 2005-2009 are displayed in Table 1.

Table 1: Annual numbers of emergency inpatient discharges and proportion of RTC-related discharges, admitted on an emergency basis, 2005-2009

YEAR	TOTAL NUMBER OF EMERGENCY INPATIENT DISCHARGES	NUMBER OF RTC-RELATED DISCHARGES	%
2005	320,680	3,080	1.0
2006	330,281	3,118	0.9
2007	335,287	2,964	0.9
2008	330,003	2,862	0.9
2009	329,535	2,837	0.9
Total	1,645,786	14,861	0.9

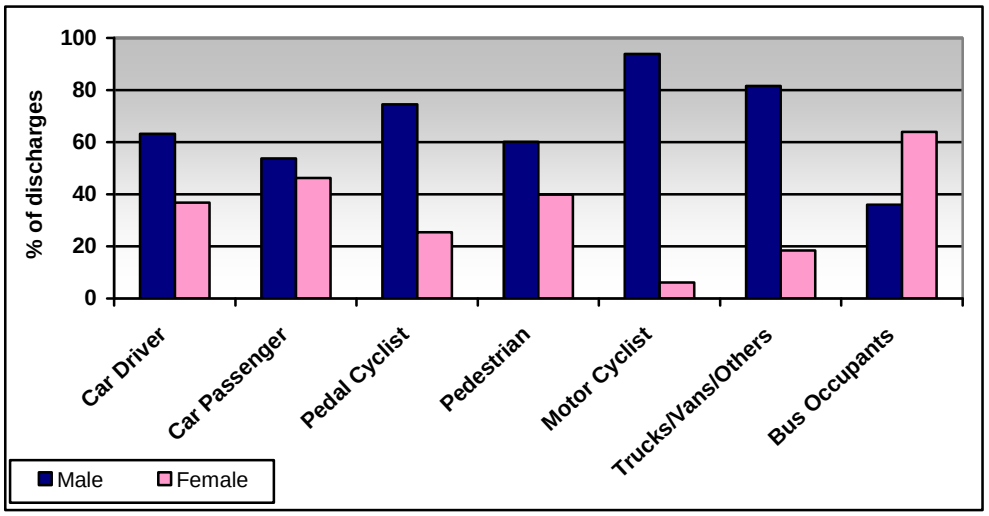
Source: HIPE

Section A: Profile of the Injured

i. Gender

Two-thirds (n=9,661, 65.0%) of the RTC-related hospital discharges were male, with one-third (n=5,200, 35.0%) female. As displayed in Figure 1, among the road user groups, with the exception of bus occupants, persons discharged from hospital were significantly more likely to be male than female, ($p<0.0001$).

Figure 1: RTC-related hospital discharges by road user group and gender

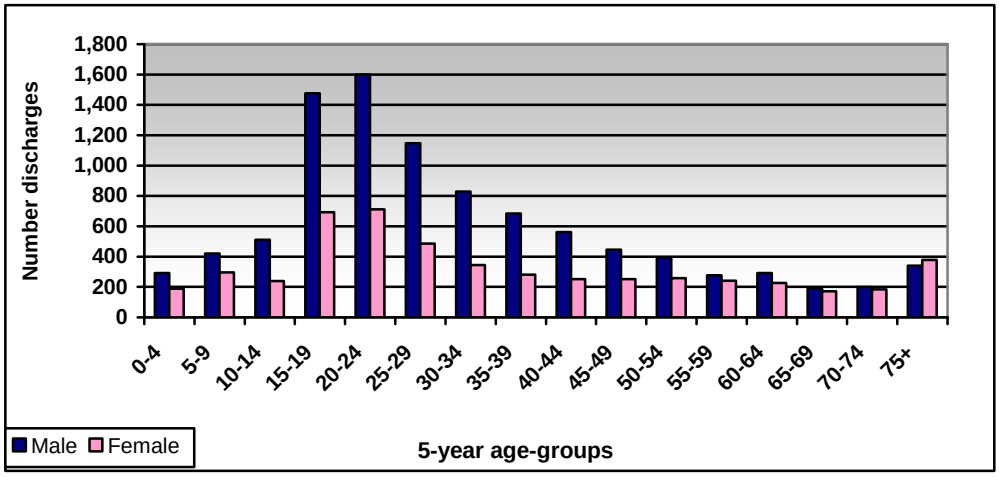


Source: HIPE

ii. Age

The average (mean) age of those discharged from hospital with an RTC-related injury was 33.1 years (Standard Deviation (SD) 20.1 years). Figure 2 details the ages of the injured by 5-year age-group, and by gender, with the highest numbers of discharges in the 15-24 year age-groups. Almost half (43.3%, n=6,430) of the injured were aged less than 25 years. Among all age-groups, with the exception of those aged 75 years and older, there were more males injured than females, ($p<0.0001$).

Figure 2: Age profile of the injured by 5-year age-groups, and gender



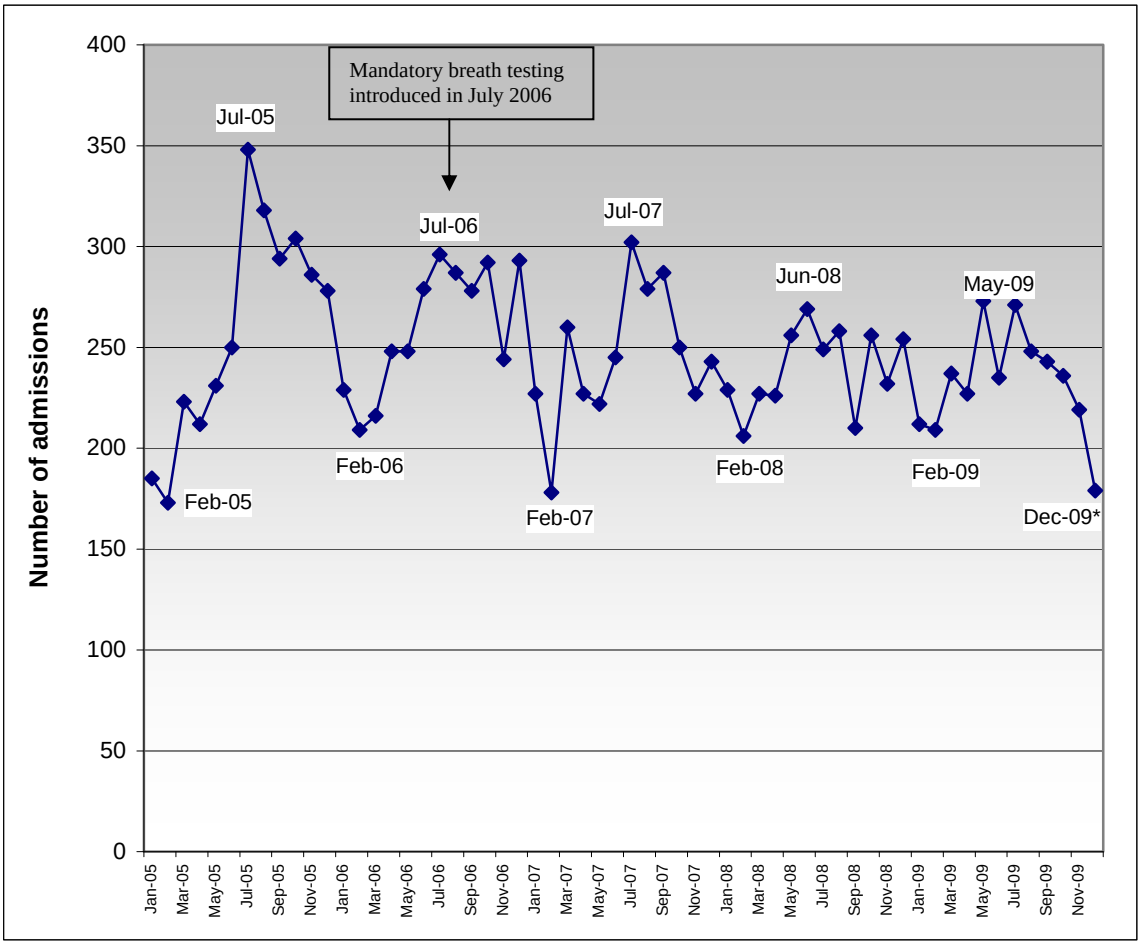
Source: HIPE

Section B: Hospital Admission

i. Month of Year of Hospital Admission

July and August were the two most common months for hospital admissions with RTC-related injuries to occur, overall. Almost two-thirds (61.6%, n=9,156) of admissions occurred in the months of 'Summer-time' (Daylight Saving Time, April-October). Figure 4 details the number of hospital admissions per month for the years 2005-2009. The seasonal variation in number of admissions is very clear from this graph, as are the decreasing number of hospital admissions as a result of RTCs over the years.

Figure 4: Month of year of hospital admission with RTC-related injury



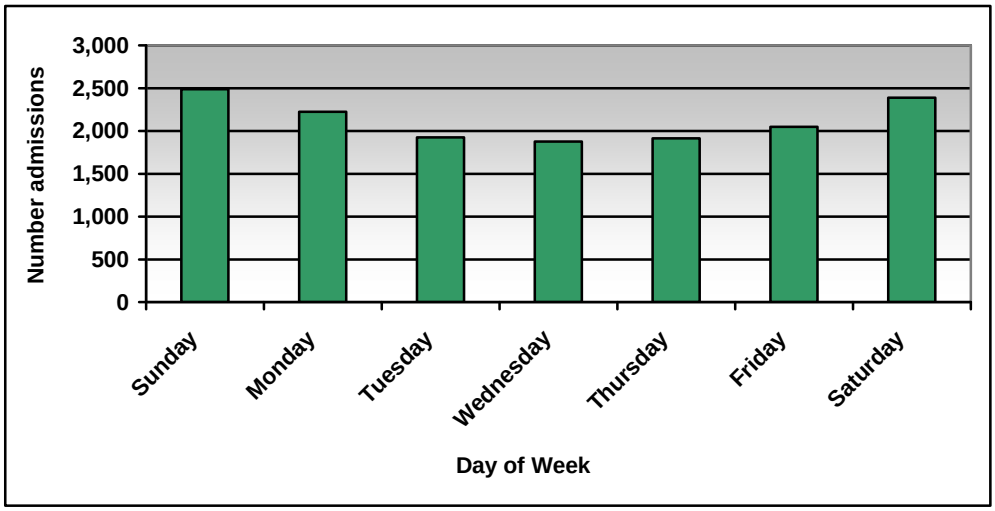
**Data for December 2009 is incomplete, as all admissions in December 2009 may not have been discharged by 31st December*

Source: HIPE

ii. Day of Week of Hospital Admission

As detailed in Figure 5 below, Saturdays and Sundays were the most common days for RTC-related injuries to be admitted to hospital, with 32.8% (n=4,875) of persons admitted on these days. Mondays (15.0%, n=2,223) and Fridays (13.8%, n=2,048) were the third and fourth most common days for admissions.

Figure 5: Day of week of hospital admission following RTCs



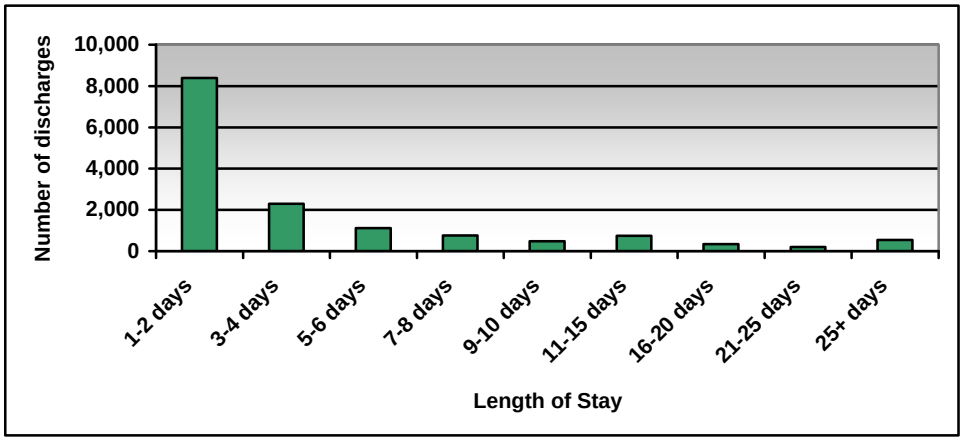
Source: HIPE

iii. Length of Stay

The average (mean) length of inpatient hospital stay for RTC-related injuries was 5.9 days (SD 15.5 days), while the median length of stay was 2 days. The total number of bed days used was 87,750 bed days, with average daily bed occupancy (ADO) of 48.1 beds per day.

Figure 6 details a length of stay (LOS) profile for these discharges, with 56.4% (n=8,385) of them having a length of stay of 1-2 days. An additional 15.5% (n=2,298) had a length of stay of 3-4 days. Cumulatively, 79.4% (n=11,797) of these patients had a length of stay of less than seven days. Just 3.7% (n=547) had a length of stay in excess of 25 days.

Figure 6: Length of stay profile



Source: HIPE

Table 2 details the average LOS, total bed days used and ADO, by road user group.

Table 2: Average LOS, bed days used and ADO by road user group

ROAD USER GROUP	NUMBER OF DISCHARGES	AVERAGE LOS (DAYS)	TOTAL BED DAYS	AVERAGE DAILY BED OCCUPANCY (ADO)
Car Driver	5,245	5.2	27,472	15.0
Car Passenger	3,729	5.1	19,154	10.5
Pedestrian	2,453	8.6	21,019	11.5
Motorcyclist	1,345	7.1	9,493	5.2
Pedal Cyclist	1,050	4.8	5,019	2.8
Pick-up Truck/Van/Other	978	5.5	5,397	3.0
Bus Occupant	61	3.2	196	0.1
Total	14,861	5.9	87,750	48.1 beds

Source: HIPE

- Pedestrians had the longest average LOS at 8.6 days. This was significantly longer than all other groups, ($p<0.0001$).
- Car drivers used the greatest number of bed days at 27,472.
- Car drivers also had the highest ADO at 15.0 beds.

iv. Length of Stay Greater than One Day

Internationally, many countries report on the number of injured persons hospitalised for more than 24 hours (excluding those who died within 30 days). The HIPE system does not report actual times of admission and discharge; therefore we examined those discharges with a length of stay of greater than one day. Overall, 59.4% (n=8,711) of these hospital discharges had a length of stay greater than one day.

Table 3 details the number of injured persons hospitalised for longer than one day, the number of fatally injured persons and the ratio of hospitalised road users to fatally injured road users for the years 2005 to 2009. The number of hospitalisations and the numbers fatally injured have both decreased in recent years. However, the ratio of hospitalised road users to fatally injured road users has increased from 4.6 persons to 7.0 persons over the five year period.

Table 3: Number of hospitalised road users (greater than 1 day) and the number of fatal injuries and the ratio of hospitalisations to fatal injuries, 2005-2009

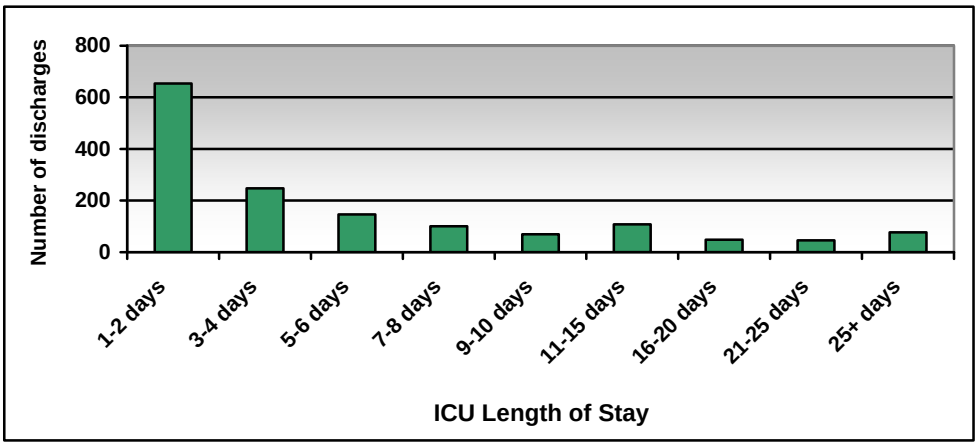
YEAR OF DISCHARGE	NUMBER OF HOSPITALISATIONS > 1DAY	NUMBER OF FATAL INJURIES ^	RATIO HOSPITALISATIONS: FATAL INJURIES
2005	1,804	396	4.6
2006	1,852	365	5.1
2007	1,703	338	5.0
2008	1,695	279	6.1
2009	1,657	238	7.0

Sources: HIPE, An Garda Síochána website^ (2009)

v. Admission to Intensive Care Unit

Overall, 10.1% (n=1,498) of all RTC-related discharges required admission to an Intensive Care Unit (ICU). The average (mean) length of stay in ICU was 7.0 days (SD 10.5 days), with a median length of stay of three days. Figure 7 details the ICU length of stay profile, with 43.7% (n=654) having a length of stay of 1-2 days. An additional 16.5% (n=247) had a length of stay of 3-4 days, with 9.8% (n=147) in ICU for 5-6 days. Cumulatively, 70.0% (n=1,048) of discharges who were admitted to an ICU had a length of stay less than seven days.

Figure 7: ICU length of stay profile



Source: HIPE

Table 4 details the admissions to an ICU, by road user group, as well as their average lengths of stay in ICU. Pedestrians were significantly more likely to be admitted to an ICU than any other road user group, ($p<0.0001$).

Table 4: Number and % of road user groups admitted to an ICU and average ICU LOS

ROAD USER GROUP	NUMBER	NUMBER ADMITTED TO ICU	% ADMITTED TO ICU	AVERAGE ICU LOS (DAYS)
Car Driver	5,245	513	9.8	6.5
Car Passenger	3,729	385	10.3	6.7
Pedal Cyclist	1,050	69	6.6	7.6
Motorcyclist	1,345	133	9.9	7.4
Pedestrian	2,453	297	12.1	7.4
Pick-up Truck/Van	978	96	9.8	8.0
Bus occupants	61	5	8.2	3.2
Total	14,861	1,498	10.1	7.0

Source: HIPE

Overall, there was no significant difference in the average ICU LOS among the different road user groups.

vi. Principal Diagnosis

Table 5 details the principal diagnoses of these RTC-related admissions. All principal diagnoses were classified using the International Classification of Diseases, version 10 (ICD-10) [24]. The most common principal diagnoses recorded were injuries to the head, with 31.2% of discharges assigned this diagnosis.

Table 5: Principal diagnoses of RTC-related discharges

PRINCIPAL DIAGNOSES (ICD-10 CLASSIFICATION)	NUMBER	%
Injuries to the head (S00-S09)	4,644	31.2
Injuries to abdomen, lower back, lumber spine and pelvis (S30-S39)	1,790	12.0
Injuries to knee and lower leg (S80-S89)	1,720	11.6
Injuries to the thorax (S20-S29)	1,495	10.1
Injuries to the elbow and forearm (S50-S59)	1,042	7.0
Injuries to the shoulder and upper-arm (S40-S49)	804	5.4
Injuries to the neck (S10-S19)	803	5.4
Injuries to hip and thigh (S70-S79)	728	4.9
Injuries to wrist and hand (S60-S69)	417	2.8
Injuries to the ankle and foot (S90-S99)	262	1.8
Other diagnoses	1,156	7.8
Total	14,861	100.0

Source: HIPE

Among those discharges with a length of stay of less than or equal to one day, the most common principal diagnoses were:

- Injuries to the head (41.8%);
- Injuries to the abdomen/back (9.1%),
- Injuries to the elbow/forearm (8.1%),
- Injuries to the thorax (7.3%).

Those discharges with a length of stay greater than one day most commonly had principal diagnoses of:

- Injuries to the head (24.0%);
- Injuries to the knee/lower leg (15.6%);
- Injuries to the abdomen/back (14.1%);
- Injuries to the thorax (11.9%),

vii. Principal Procedures

Two-thirds (65.1%, n=9,672) of those admitted with a RTC-related injury had a procedure recorded. These principal procedures were classified using ICD-10 procedure blocks, and then using ICD-10 categories [25]. Table 6 details these principal procedures, with procedures on the musculoskeletal system (39.6%) most common. The second most common principal procedures were imaging services.

Table 6: Principal procedures of RTC-related discharges

PRINCIPAL PROCEDURES (ICD-10 CATEGORY)	NUMBER	%
Procedures on musculoskeletal system (Blocks 1360-1579)	3,827	39.6
Imaging services (Blocks 1940-2016)	2,668	27.6
Non-invasive, cognitive and other interventions, not elsewhere classified (Blocks 1820-1922)	1,108	11.5
Dermatological and plastic procedures (Blocks 1600-1718)	823	8.5
Procedures on respiratory system (Blocks 520-569)	610	6.3
Procedures on nervous system (Blocks 1-86)	246	2.5
Procedures on digestive system (Blocks 850-1011)	159	1.6
Procedures on nose, mouth and pharynx (Blocks 370-422)	56	0.6
Procedures on cardiovascular system (Blocks 600-767)	37	0.4
Procedures on blood and blood-forming organs (Blocks 800-817)	36	0.4
Procedures on the eye and adnexa (Blocks 160-256)	31	0.3
Procedures on urinary system (Blocks 1040-1129)	28	0.3
Procedures on ear and mastoid process (Blocks 300-333)	23	0.2
Dental Services (Blocks 450-490)	7	0.1
Other	13	0.1
Total	9,672	100.0

Source: HIPE

Table 7 details below the most commonly reported principal procedures within the category of 'procedures on the musculoskeletal system', with open reduction of fracture of femur with internal fixation most common.

Table 7: Most commonly reported procedures under category of musculoskeletal system

PROCEDURE	N (%)	BLOCK DESCRIPTION
4752801	241 (6.3%)	Open reduction of fracture of femur with internal fixation
4760001	236 (6.2%)	Open reduction of fracture of ankle with internal fixation of diastasis, fibula or malleous
4756601	229 (6.0%)	Open reduction of fracture of shaft of tibia with internal fixation
4736302	201 (5.3%)	Closed reduction of fracture of distal radius with internal fixation
4736602	175 (4.6%)	Open reduction of fracture of distal radius with internal fixation
Other	2,745 (71.7%)	Other procedures on the musculoskeletal system
Total	3,827 (100%)	

Source: HIPE

Table 8 below details the most commonly reported principal procedures within the category of 'imaging services', with computerised tomography of the brain most common.

Table 8: Most commonly reported procedures under category of imaging services

PROCEDURE	N (%)	BLOCK DESCRIPTION
5600100	1,113 (41.7%)	Computerised tomography of brain
5622000	225 (8.4%)	Computerised tomography of spine, cervical region
5640100	124 (4.6%)	Computerised tomography of abdomen
5650700	116 (4.3%)	Computerised tomography of abdomen and pelvis with intravenous contrast medium
5622300	110 (4.1%)	Computerised tomography of spine, lumbosacral region
9090103	110 (4.1%)	Magnetic resonance imaging of spine
Other	870 (32.6%)	Other imaging services
Total	2,668 (100%)	

Source: HIPE

viii. Discharge Outcome

Table 9 details the patients' destination following their hospital discharge, with 83.6% (n=12,429) of them going home directly from hospital. In total, an additional 10.8% (n=1,601) of discharges are transferred to other hospitals (acute & non-acute) on both emergency and non-emergency basis, while 1.4% (n=211) of discharges died in hospital. No statistically significant association was found between day of admission and discharge outcome.

Table 9: Discharge outcome for RTC-related discharges

DISCHARGE OUTCOME	NUMBER	%
Home	12,429	83.6
Transfer to acute hospital - non emergency	820	5.5
Transfer to acute hospital - emergency	781	5.3
Self Discharge	273	1.8
Nursing home, convalescent home, long stay accommodation	231	1.6
Died	211	1.4
Absconded	28	0.2
To Rehabilitation	22	0.1
Transfer to psychiatric unit	19	0.1
Transfer to non-acute hospital - non emergency	17	0.1
Transfer to non-acute hospital - emergency	<5	0.0
Other	26	0.2
Total	14,861	100.0

Source: HIPE

Of the 211 persons who died in hospital from the injuries they sustained in their RTC, the majority (96.2%, n=203) of them died within 30 days of their hospital admission, therefore meeting the RSA definition of a 'Fatal Collision' [2].

Table 10 details the discharge destination by road user group, with injured pedestrians significantly less likely than any other group, to be discharged directly home from hospital, ($p<0.0001$). Compared to the other groups, pedestrians had the highest proportion of deaths in hospital and the highest proportion requiring discharge to a nursing home, convalescent home or rehabilitation.

Table 10: Discharge destination of admissions with a RTC-related injury by road user group

	HOME	TRANSFER TO ANOTHER HOSPITAL	DIED	NURSING HOME/ CONVALESCENT/ REHAB	OTHER
ROAD USER GROUP	% (N)	% (N)	% (N)	% (N)	% (N)
Car Driver	84.3 (4,421)	10.3 (542)	1.3 (67)	1.5 (77)	2.6 (138)
Car Passenger	83.9 (3,130)	11.2 (416)	1.3 (48)	1.3 (47)	2.4 (88)
Pedal Cyclist	89.9 (944)	6.3 (66)	1.2 (13)	1.2 (13)	1.3 (14)
Motorcyclist	83.4 (1,121)	13.4 (180)	0.8 (11)	0.8 (11)	1.6 (22)
Pedestrian	78.5 (1,925)	12.7 (312)	2.7 (65)	3.9 (96)	2.2 (55)
Pick up/Truck/Van/Other	85.3 (834)	10.2 (100)	0.7 (7)	0.9 (9)	2.9 (28)
Bus	88.5 (54)	9.8 (6)	0.0	0.0	1.6 (<5)

Source: HIPE

ix. Cost of Inpatient Hospital Care

The cost of inpatient hospital care for these RTC-related hospital discharges, admitted on an emergency basis, was calculated using Health Atlas Ireland. Table 11 details these costs for the years 2005-2008. These costs do not include the costs of outpatient attendance, ED attendance or day case admissions, as complete computerised data do not exist. However, these costs do include any pre-existing conditions the person may have had at the time of hospital admission, and are not exclusively RTC-related costs. Costs for 2009 were not finalised at the time of analysis.

Table 11: Hospital Costs (inpatient) for RTC-related discharges, 2005-2008

YEAR	NUMBER OF DISCHARGES	COSTS (€ MILLIONS)
2005	3,107	18.1
2006	3,143	19.6
2007	2,991	19.5
2008	2,891	20.3
Total	12,132	77.5

Source: Health Atlas Ireland, December 2010

For the period of 2005-2008, hospital inpatient costs increased by 12% over the four year period, while the number of discharges decreased by 7.0%.

Table 12 details the breakdown of inpatient hospital costs for those admitted as an emergency with RTC-related injuries, by road user group, for the four year period, with car occupants the most expensive group. Also detailed in this table are the average inpatient hospital costs per injury sustained overall and per user group. Overall, according to these data, the inpatient hospital costs for any RTC-related injury, admitted on an emergency basis were €6,395, on average. By road user group, the inpatient hospital costs associated with injuries to motorcyclists were most expensive, averaging €8,491.

Table 12: Emergency hospital inpatient costs for RTC-related injuries, 2005-2008

ROAD USER GROUP	2005 (€MILLIONS)	2006 (€MILLIONS)	2007 (€MILLIONS)	2008 (€MILLIONS)	TOTAL COST (€MILLIONS)	AVERAGE COST
Car Occupants	9.6	10.9	11.0	11.0	42.4	€5,818
Pedal Cyclists	1.1	1.0	0.9	1.1	4.2	€5,173
Motorcyclists	2.2	1.8	2.6	2.7	9.3	€8,491
Pedestrians	3.8	4.5	3.7	4.3	16.4	€7,926
Vans/ Trucks/Other	1.4	1.4	1.3	1.2	5.3	€6,098
Total	18.1	19.6	19.5	20.3	77.6	€6,395

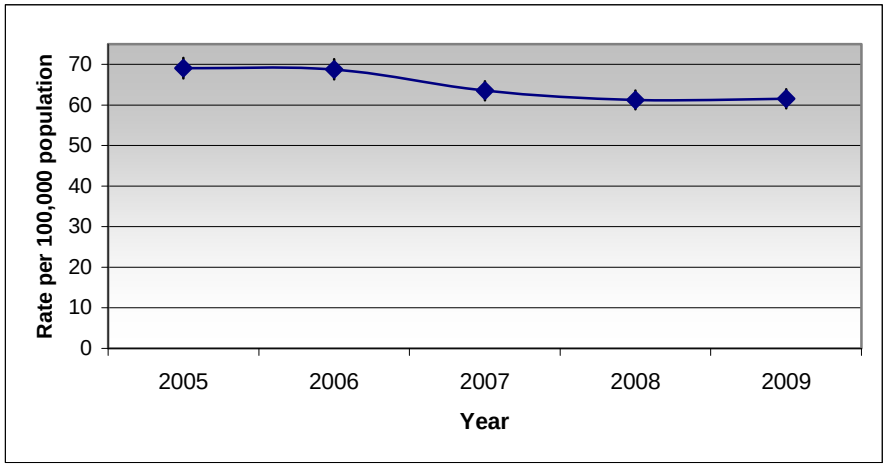
Source: Health Atlas Ireland, December 2010

Section C: Trends 2005-2009

i. Discharges from Hospital with an RTC-related Injury (excluding fatal injury)

Figure 8 details the age standardised discharge rate for Irish residents with RTC-related injuries (excluding those who died within 30 days of admission) by year for the period of 2005 to 2009. The age standardised rate decreased significantly from 69.1 per 100,000 populations in 2005 to 61.5 per 100,000 populations in 2009, ($p<0.01$).

Figure 8: Age standardised discharge rate per 100,000 populations for RTC-related injuries (excluding those who died within 30 days of admission), 2005-2009

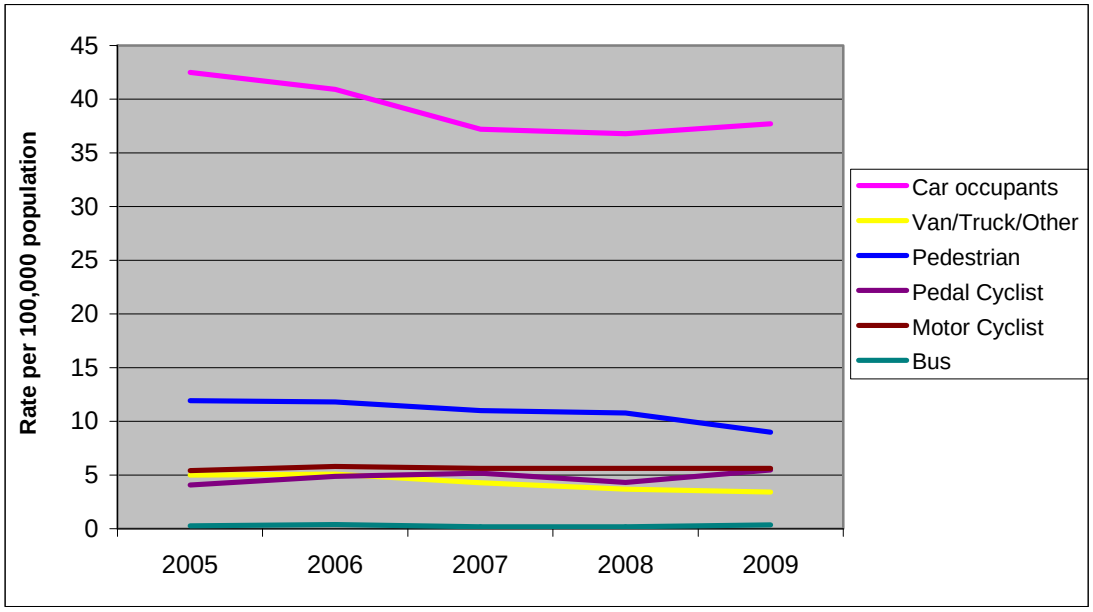


Source: HIPE & CSO

ii. Discharges from Hospital by Road User Group, 2005-2009

Figure 9 details the age-standardised discharge rate by road user group for the period 2005-2009. There was a downward trend among several categories of road user group between 2005 and 2009, namely car occupants, pedestrians and occupants of van/trucks/pick-ups. There were more motorcyclists, pedal cyclists and bus occupants injured in 2009 compared to 2005.

Figure 9: Age-standardised discharge rate per 100,000 population for RTC-related injuries by road user group (excluding fatal injuries), 2005-2009



Source: HIPE

iii. Patients' Area of Residence

Table 13 details the average number of discharges by Irish residents with an RTC-related injury (excluding those who died within 30 days of admission), by county, for the years 2005-2009. The highest average numbers of discharges were recorded by residents of counties Dublin, Cork, Donegal and Tipperary. Also detailed are the age-standardised average discharge rates per 100,000 populations for each county, with the highest rates recorded among residents of counties Donegal and Roscommon, with rates in excess of 125 per 100,000 populations.

Table 13: Average number of hospital discharges with RTC-related injury (excluding fatal injury), and standardised average discharge rate per 100,000 population (95% confidence interval) for RTC-related injuries by county, 2005-2009

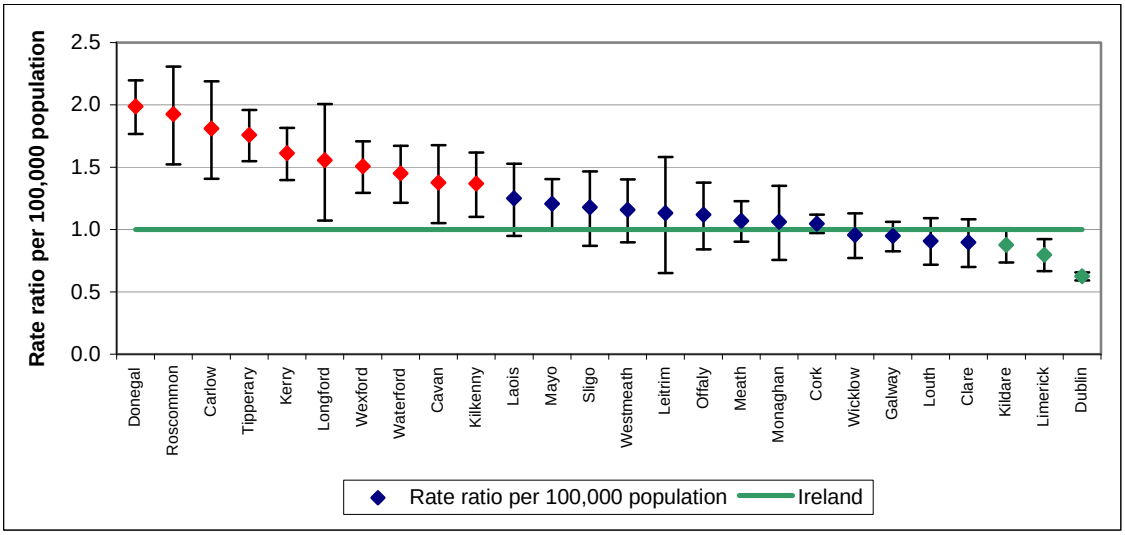
AREA OF RESIDENCE	AVERAGE NUMBER OF HOSPITAL DISCHARGES PER YEAR, 2005-2009	AGE-STANDARDISED AVERAGE DISCHARGE RATE PER 100,000 POPULATION (95% CI)
Ireland	2,859	65.6 (63.1-68.0)
Leinster		
Carlow *	60	118.8 (88.8-148.9), (p<0.001)
Dublin ^	489	41.0 (37.3-44.6), (p<0.001)
Kildare ^	106	57.6 (46.4-68.8), (p<0.001)
Kilkenny *	76	89.7 (69.4-110.0), (p<0.001)
Laois	53	81.9 (59.9-104.0)
Longford *	34	102.0 (67.7-136.4), (p<0.001)
Louth	66	59.6 (45.2-74.1)
Meath	111	70.2 (57.0-83.4)
Offaly	51	73.4 (53.1-93.6)
Westmeath	59	76.0 (56.6-95.4)
Wexford *	126	98.9 (81.6-116.2), (p<0.001)
Wicklow	77	62.7 (48.7-76.7)
Munster		
Clare	62	58.9 (44.1-73.6)
Cork	331	68.7 (61.3-76.1)
Kerry *	140	105.8 (88.1-123.5), (p<0.001)
Limerick ^	98	52.4 (42.0-62.8), (p<0.001)
Tipperary *	165	115.4 (97.7-133.2), (p<0.001)
Waterford *	101	95.1 (76.6-113.6), (p<0.001)
Connacht		
Galway	147	62.2 (52.2-72.3)
Leitrim	20	74.3 (41.0-107.5)
Mayo	93	79.2 (62.8-95.6)
Roscommon *	69	126.5 (96.0-156.9), (p<0.001)
Sligo	46	77.3 (54.8-99.7)
Ulster		
Donegal *	185	130.5 (111.5-149.4), (p<0.001)
Cavan *	56	90.2 (66.4-114.0), (p<0.001)
Monaghan	39	69.7 (47.7-91.8)

Source: HIPE **** significantly higher than the national average, ^ significantly lower than the national average***

Figure 10 details the directly age-standardised rate ratios for all 26 counties. These rate ratios were calculated by dividing the directly age-standardised average discharge rate for each county by the age-standardised average discharge rate for Ireland, for the years 2005-2009.

The highest average discharge rate ratio for RTC-related injuries was for county Donegal at twice (2.0, 95%CI: 1.8-2.2) the average discharge rate for Ireland. The lowest rate ratio was calculated for Dublin at 0.6 (95%CI: 0.6-0.7).

Figure 10: Average discharge rate ratios, by county of residence (Ireland=1), 2005-2009



There were ten counties with average discharge rate ratios significantly higher (highlighted red) than the average for Ireland (26). These counties were Donegal, Roscommon, Carlow, Tipperary, Kerry, Longford, Wexford, Waterford, Cavan and Kilkenny.

Thirteen counties had an average discharge rate ratio similar to the average for Ireland. These counties were Laois, Mayo, Sligo, Westmeath, Leitrim, Offaly, Meath, Monaghan, Cork, Wicklow, Galway, Louth and Clare.

Three counties had average discharge rate ratios significantly lower (highlighted green) than the average for Ireland. These were Kildare, Limerick and Dublin.

Section D: Comparisons

i. Road Safety Authority Data

Each year, the RSA publishes a report on road collision facts for the previous year. Table 14 details the number of serious injuries which they reported for the years 2005-2009,[2, 20-23] as well as the number of hospital inpatient discharges with a RTC-related injury for the same period as reported in this report.

Table 14: Annual numbers of serious injuries reported by the RSA and RTC-related hospital discharges reported in HIPE, and the ratio in numbers between sources, 2005-2009

YEAR	SERIOUS INJURIES RSA DATA	HOSPITAL DISCHARGES HIPE DATA	RATIO HIPE:RSA
2005	1,021	3,080	3.0
2006	907	3,118	3.4
2007	860	2,964	3.4
2008	835	2,862	3.4
2009	640	2,837	4.4
Total	4,263	14,861	3.5

Sources: RSA & HIPE, 2005-2009

Comparing the information from these two data sources for the years 2005 to 2009, the difference between the numbers extracted from the HIPE system and the numbers reported in the annual RSA reports is more than three-fold (3.5). Given that the RSA definition of serious injury as described in the methods section of this paper, includes persons with various injuries that do not require inpatient care, the under-reporting of injuries in the RSA reports is even greater.

- **Serious Injury by Road User Group**

Tables 15 (a) and 15 (b) detail the breakdown of seriously injured persons, by road user group, as reported by the RSA and HIPE. Once again, when comparing the figures, the under-reporting of serious injury by each road user group in the RSA reports is obvious compared to HIPE.

Table 15 (a): Annual numbers of persons seriously injured in RTCs as reported by the RSA, by road user type, 2005-2009

ROAD USER GROUP	2005	2006	2007	2008	2009	TOTAL	% OF ALL
Car Occupants	616	569	542	554	414	2,695	63.2
Pedal Cyclist	24	18	19	27	21	109	2.6
Pedestrian	157	134	146	137	103	677	15.9
Motorcyclist	102	82	61	62	54	361	8.5
Pick Up Truck/Van/Other	122	104	92	55	48	421	9.9
Total	1,021	907	860	835	640	4,263	100.0

Source: RSA 2005-2009

Table 15 (b): Annual numbers of persons discharged from hospital with a RTC-related injury as reported by HIPE, by road user type, 2005-2009

ROAD USER GROUP	2005	2006	2007	2008	2009	TOTAL	% OF ALL
Car Occupants	1,902	1,867	1,757	1,715	1,733	8,974	60.4
Pedal Cyclist	169	210	230	197	244	1,050	7.1
Pedestrian	522	523	495	499	414	2,453	16.5
Motorcyclist	255	275	275	274	266	1,345	9.1
Pick Up Truck/Van/Other	232	243	207	177	180	1,039	7.0
Total	3,080	3,118	2,964	2,862	2,837	14,861	100.0

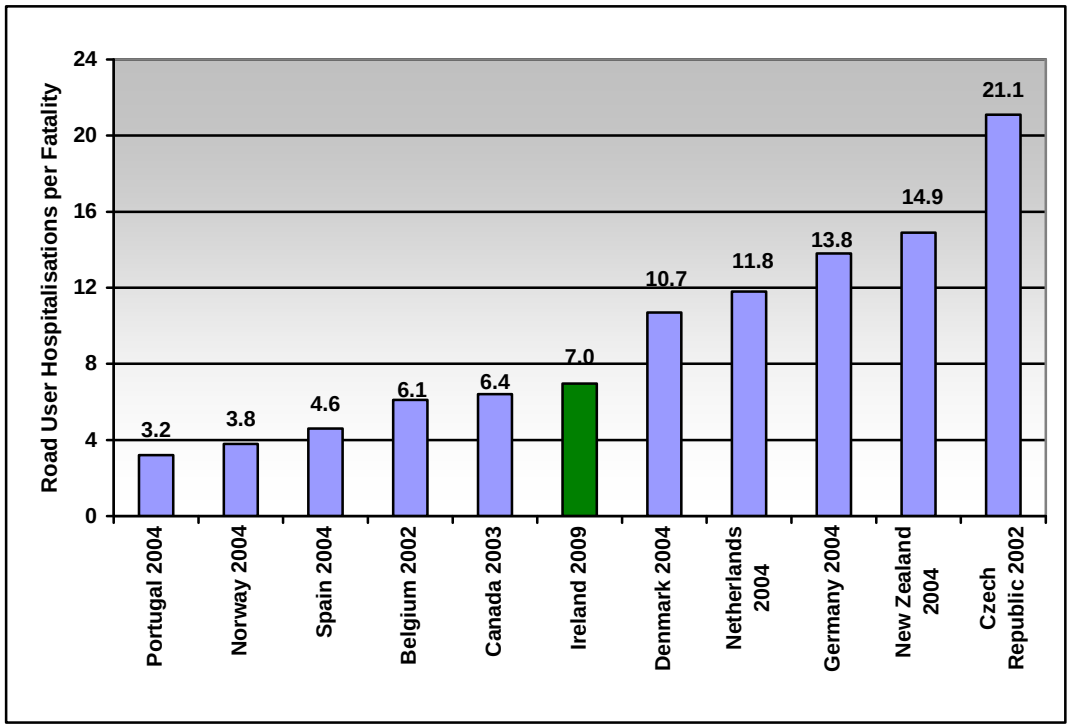
Source: HIPE 2005-2009

The largest group of injured persons reported by both sources were car occupants. There were some differences in the profile of road users among both sources. Looking at pedal cyclists in particular, HIPE data reported 1,050 (7.1%) hospital discharges over the five year period; this compares to 109 (2.6%) seriously injured pedal cyclists as reported by the RSA. The difference in numbers is almost ten-fold.

ii. International Comparisons

Figure 11 details the ratio of the number of hospitalised road users (length of stay greater than 24 hours and excluding those who died within 30 days of admission) per fatally injured road user for selected OECD member countries for 2004 as reported by the International Road Traffic and Accident Database (IRTAD) [4]. Data for Ireland are for 2009. As highlighted, Ireland is mid-way on the graph, with 7.0 persons hospitalised for every one person fatally injured in 2009. Portugal (2004) reported three hospitalisations per fatality, while the Czech Republic (2002) reported 21 hospitalisations per fatality.

Figure 11: Number of hospitalised road users with length of stay > 24 hours per fatally injured road users selected OECD member countries, 2004*



Source: IRTAD, 2007, HIPE & An Garda Síochána for Irish Data 2009.*

Discussion

It is important to have data which give a reasonable estimation of the number of people who suffer serious non fatal injuries resulting from collisions on Irish roads. Without these data it will not be possible to fully evaluate the effectiveness of measures aimed at reducing such injuries and plan appropriate strategies. The Road Safety Strategy for 2007-2012 stated that it was not possible to set a benchmark for a reduction in serious injuries as there were doubts about the reliability of the reported figures [3]. This study has confirmed that those doubts were in fact reflecting reality and has identified a major under-reporting of serious injuries following RTCs. Over the five year period of 2005-2009, there were 14,861 RTC-related hospital discharges. By definition these meet the RSA's definition of serious injury. This number is 3.5 times greater than the number reported by the RSA using An Garda Síochána data (4,263). The under-estimation is even greater as this report does not include data from EDs in acute hospitals, as these data are not available nationally on a computerised database, or indeed data in respect of patients who may have attended their GP or private hospitals.

This finding is not surprising given that other countries have reported similar under-estimation in the numbers injured in RTCs. Research elsewhere has shown that multiple data sources provide a more accurate picture of the true extent of road injuries [4, 5]. A French study highlighted that using police data only accounted for just 37% of injuries [6]. New Zealand research in 1995 has shown that less than a third of hospitalised patients were recorded by the police [7]. A recent paper concluded that the decline in serious road injuries in the United Kingdom, seen in official police reports, probably reflected a fall in the completeness of the police statistics rather than a decline in injuries as hospital injury data showed no decline [26]. Reliance on one set of data may give a misleading impression of an improving situation without another source of data to augment or validate it. Ideally information systems should be linked to get the best information, with personal identification codes for linking, if possible [4]. The Western Australian Road Injury Database is an example of such a system. It uses on-going linkage of crash details from police reports with the details of injuries in hospital and death records. This allows for estimates of under-reporting of crashes for different road user groups [8]. A Swedish study reported that there was a difference in the recording rate for different means of transport, with pedal cyclists having the

lowest rate [27]. This is also true in this study; cyclists accounted for 7.1% of those admitted to hospital with an RTC-related injury. However, over the same period, they only account for 2.6% of serious injuries as reported by the RSA. Looking at multiple datasets, reveals the true extent of injuries sustained due to RTCs and therefore allows policy-makers to make appropriate decisions. RSA data is exclusively based on An Garda Síochána reports using the CT68 form. This form is completed by Gardaí, often at the scene of the crash, and always within three days of the crash. Of course, not all injuries or crashes are reported to the Gardaí.

This report presents important information on the number of persons admitted to all acute hospitals nationwide following RTCs for a five year period. This information has not been published before. HIPE is the main data source. This is the only source of morbidity data available nationally for all acute hospital services in Ireland. It has high quality controls and is managed by the Health Research & Information Division of the ESRI. There are over 1.3 million episodes of care recorded annually. There are limitations to this study. No data were available from EDs, outpatient departments, private hospitals or from GPs. Thus at best the data presented here is an underestimate of the true burden. The data source itself (HIPE) records episodes of care and does not allow for the tracking or linking of individual patients through the hospital system. Due to the lack of unique identifiers, some repeat admissions may have been included if a patient was admitted to a different hospital and therefore given a different medical record number. In addition, a number of patients may have been coded as an emergency admission when transferred from another hospital, when they should have been coded as a transfer. However, given that the vast majority of patients were discharged home and there was only a small minority transferred to other hospitals, it is considered that this limitation does not affect the main results in any significant manner.

The trend over the five year period of 2005-2009 shows a statistically significant reduction in the number of patients treated in hospital. However, this reduction of 7.9% is significantly less than the 37.3% reduction in serious injuries reported in the RSA figures. The dramatic reduction in numbers from 2005 to 2006 reported in this study may have been contributed to by the introduction of mandatory breath testing in July 2006. While the numbers injured have decreased, the ratio of the number of

hospitalisations to the number fatally injured has increased; this is because the numbers injured has not decreased as dramatically over time as the numbers fatally injured.

In this study on injuries, among all age-groups, with the exception of those aged 75 years and older, there were significantly more males injured than females. This is in keeping with the pattern seen in fatal crashes where young males are seen to be at greatest risk of being killed in an RTC [2, 20-23]. Morgan et al reported in 2008 that the percentage of the population who reported driving a car after consuming two or more standard alcoholic drinks in the previous 12 months had decreased from 16% in 2002 to 12% in 2007. However, there was no decrease among male drivers aged 18-29 years, with the proportion remaining at 18% [28]. Other research has reported on this risky behaviour among male drivers, with Irish male drivers reporting that the fear of being caught by the police is the main reason why they don't drink and drive, and not their own safety or the safety of others [29].

Seasonal variation in hospitalisation following RTCs has been described before [26]. There is a clear pattern in this study of higher rates in the summer months. Clearly this indicates that there is an ongoing requirement for highly visible enforcement by An Garda Síochána during the summer months backed up by publicity campaigns to alert drivers and other road users of the dangers, particularly at this time of year.

Pedestrians had the longest average length of stay in hospital following a RTC; they were also more likely to need to be treated in intensive care units and were significantly less likely to be discharged directly home from hospital, than other road user groups. Pedestrians are vulnerable road users and need all the protection that is available to them. Urban and residential areas should all have reduced speed limits of 30 kph as data exist that show that reduced speed limits can reduce the number of casualties by 42% with the benefit greatest amongst children [30].

The high proportion of admissions at weekends reflects the pattern of RTCs in Ireland and elsewhere. However, this time period coincides with that time in the hospital when least staff are available to deal with major trauma. According to the international literature there is evidence that patients admitted at weekends have worse outcomes [31, 32]. Possible reasons to explain this weekend effect would include

less availability of experienced clinicians and other staff at weekends [33]. This study did not identify worse outcomes for those admitted at weekends. This may well be the case. However, the data available do not contain time of presentation to the hospital and therefore it was not possible to clearly identify the week end period (Friday evening to early Monday morning). More complete ED data and linked data (ambulance, police and hospital data) would facilitate a proper analysis of this.

Hospital inpatient costs increased (12%) during 2005-2008 although the number of RTC-related hospitalisations decreased; this is probably a reflection of medical inflation. The average cost of the acute hospital inpatient care for the years 2005-2008 for an RTC-related injury was €6,395 per patient. These costs do not include care in the EDs, in outpatient departments, or day case admissions, so the costs to the hospital system are even greater. The current information systems available do not allow for an accurate estimation of costs. Hospital costs are not the only costs resulting from RTCs. Other costs include costs to the police, fire services, loss of income to the injured persons and loss of productivity at an employment level. In 2004, Goodbody Consultants estimated the cost of a serious injury crash at €304,600 [34]. The data presented in this report highlights the major under-reporting of serious injury crashes using An Garda Síochána data only. Therefore, the overall cost of these injuries to the economy must be also greater than previously envisaged if based on the routinely reported data. The cost to the economy based on the number of hospitalised patients for the five year period identified in this study and the Goodbody Consultants data would have been €4.5 billion or an average of €0.9 billion per annum. This highlights the potential to save not just injuries and lives, but also serious costs to the economy by implementing evidence based road safety initiatives, such as drink driving legislation, general speed limits, reduced speed limits in urban areas and enforcement of existing legislation.

This is the first national report on injuries requiring hospitalisation in Ireland. The data are available through Health Atlas Ireland and should be reported on as a routine each year and be used in conjunction with An Garda Síochána and other data to provide realistic and timely injury trends. Ideally, the data should be linked as in other countries; however, the lack of a unique identification system and data protection issues remain as obstacles to the linking of these data [35].

Acknowledgements

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