Risk of Permanent Medical Impairment (RPMI) in Road Traffic Accidents

Sigrun Malm, MSc, Maria Krafft, PhD, Anders Kullgren, PhD, Anders Ydenius MSc
Folksam Research, Stockholm, Sweden and Karolinska Institutet, Solna, Sweden

Claes Tingvall, Prof
Swedish Road Administration, Borlänge, Sweden and Monash University Accident Research Centre, Melbourne, Australia

ABSTRACT – In addition to investigating risk of death due to road traffic injuries, there is a need to better describe the risk of serious consequences. This study assessed risk of permanent medical impairment based on road traffic injuries classified according to AIS-2005. Injured car occupants were followed for at least 5 years to assess permanent medical impairment. After an initial injury, the risk of permanent impairment was established for injuries to different body regions and AIS levels. Degree of impairment was assessed according to a manual used by all Swedish insurance companies. Those included in the study were 20,484 car occupants injured in crashes that occurred between 1995 and 2001. Three risk levels of sustaining a permanent medical impairment (RPMI) were made. It was concluded that almost 10% of all car occupants with AIS1 injuries sustained a permanent medical impairment. It is therefore important to include minor injuries leading to impairment when measuring loss of health due to road traffic crashes. Furthermore the highest risk of sustaining a permanent medical impairment from an AIS1 injury was associated with injuries to the cervical spine and upper and lower extremities. One third of AIS3 head and cervical spine injuries led to the highest RPMI level of impairment. Injuries to the thorax and abdomen gave the lowest risk of permanent medical impairment on all AIS levels and all impairment levels. The result can be used for road transport system strategies, and for making priority decisions in vehicle design.

INTRODUCTION

Each year, more than 1.2 million people are fatally injured and an estimated 20–50 million are injured worldwide due to motor vehicle crashes [Peden, Scurfield, Sleet, et al., 2004]. In Sweden, as in many other developed countries, the number of fatally injured persons is decreasing [SIKA, 2006; IRTAD, 2007], while the number who are reported to be severely injured is decreasing at a much slower pace, and the total number of injured persons is increasing. In road traffic injury prevention work, it is important not only to study fatal crashes when deciding what measures should be taken to reduce loss of health, since the number of people injured is several times higher than the number of fatalities. A significant problem when focusing on information from non-fatal crashes is that there is a poor correlation between immediate assessment of the severity of an injury and the long-term consequences [Nygren, 1984; Galasko, Murray, Hodson, 1986]. An important issue is therefore the development of an appropriate system for determining which injuries lead to long-term consequences, in order to identify priorities in the area of injury prevention.

Several systems are used to classify injuries. Most of the scales and classification systems report the status of the injured person at the time of the coding. Examples of this are ICD-10 (International Classifications of Diseases) [WHO, 1992] and police records which refer to the individual's status shortly after the crash.
There are also several ways of measuring health-related quality-of-life after an injury (HR-QOL), e.g. SF-26 and the EuroQol instrument (EQ-5D) [Coons, Rao, Keininger, et al, 1990]. Individuals report their status at the time of coding, with regard to loss of body function, pain and the ability to handle daily activities. These systems are mostly used to measure the change in health status over time.

Most predictive scales assess risk of death based on the immediate diagnosis after the crash. The most commonly used is the Abbreviated Injury Scale (AIS) [AAAM, 2005]. The AIS is a consensus-based scale, which is mainly a threat-to-life scale and only assesses a single injury. Several other predictive scales based on the AIS address multiple injuries and the risk of fatality, e.g. Injury Severity Score (ISS) [Baker, O'Neill, Haddon, et al, 1974], New Injury Severity Score (NISS) [Osler, Baker, Long, 1997]

and Maximum Abbreviated Injury Scale (MAIS) [AAAM, 1985].

Two methods have been developed, by Hirsch and Eppinger (1983) and Miller (1993), to assign an impairment score to several AIS diagnoses. These are based on consensus among medical specialists and on loss of earning for individuals. Another scale is the Injury Impairment Scale (IIS) [AAAM, 1994], which seems to poorly reflect the true outcome of impairment [Bradford, Thomas and Chambers, 1994, von Koch, Nygren and Tingvall, 1994]. The Functional Capacity Index (FCI) [MacKenzie, Damiano, Miller, et al, 1996] is a consensus-based score assigned to AIS injuries, reflecting the probable degree of functional capacity that remains one year after the injury. A new version of the FCI assigned to each AIS-2005 injury descriptor is anticipated [AAAM, 2005].

In 1985 Gustafsson, Nygren and Tingvall presented a Rating System for Serious Consequences (RSC), where both risk of fatality and medical permanent impairment were calculated and combined. The risk of fatality was based on ISS, and the risk of impairment for different body regions and AIS levels was based on an impairment scale used by all Swedish insurance companies. The rating system was based on AIS-1980. The system is used for rating car safety [Hägg, Kamrén, v Koch et al 1992; Hägg, Krafft, Kullgren et al 2001].

There is a need for a new impairment risk table based on a later version of the AIS, reflecting changes in severity levels in the AIS scale as well as the impact of different medical treatment on the outcome of various injuries.

The aim of this study is to present the risk of permanent medical impairment for different body regions and AIS levels based on Swedish insurance data. The impairment risk table could be used to predict the number of persons with impairments due to road traffic injuries, based on AIS-2005 coding immediately after the crash. This would make it possible to better measure loss of health over time and enable prioritization of what measures need to be taken by road system designers, car makers etc to decrease loss of health.

METHODS

The data set used consisted of 20,484 injured occupants in motor vehicle crashes reported to Folksam (a Swedish insurance company) during the years 1995 to 2001. The injured occupants travelled in 16,450 cars, and a total of 34,755 assigned diagnoses were reported. All diagnoses were classified according to AIS-2005 and followed for at least 5 years, in order to assign a degree of permanent medical impairment. This will be explained in more detail below.

Insurance Company Handling of Injuries

Folksam is one of Sweden's largest motor insurance companies. Every year Folksam handles approximately 50,000 motor vehicle claims, and approximately 10,000 persons report an injury after a collision in a motor vehicle insured by Folksam. For minor injuries such as external contusions, muscle strain or small lacerations, where the inconvenience of the injury soon passes and the injured person does not have further claims, no further patient records are requested. For all other injuries, full case records are collected and stored in the insurance file.

Initial Injury Diagnosis Coding

All initial diagnoses, even self-reported minor injuries, were classified according to AIS-2005. The classification was made by a group of seven trained persons. The results in this paper are presented in groups according to the eleven body regions of AIS-2005 except for the region "external", which (as in the ISS body region "external") includes all lacerations, contusions, abrasions and burns, independent of their location on the body surface. This was done because these soft tissue injuries showed a completely different risk of permanent medical impairment compared with other AIS1 injuries in the same region.

Impairment Assessment

If the injured person has not recovered from the injury after 6 to 12 months, the injury is assessed by medical doctors who specialize in assessing injuries according to rules called "Grading Medical Impairment", used by all Swedish insurance companies [Sveriges Försäkringsförbund, 2004]. The injury is given a degree of temporary or permanent medical impairment between 1% and 99%.

Permanent medical impairment. The principles of grading medical impairment have developed since the beginning of the 20th century and have been established in consensus between medical doctors, claims adjustment specialists and lawyers who specialize in insurance matters. Medical Impairment is defined by this manual as physical and/or mental functional reduction, independent of cause and without regard to the occupation, hobbies or other special circumstances of the injured person. When assessing the injury, all patient records before and

after the car crash are available, so the estimated degree of impairment is the functional reduction originating from the car crash. A medical impairment is considered permanent when no further improvement in physical and/or mental function is expected with additional treatment. This would in most cases occur three years, at the maximum, after the collision. For some diagnoses and persons it could take five years, and for growing children with brain injuries it usually takes until they have grown up to determine their permanent medical impairment. In the meantime, a degree of temporary medical impairment is assigned, with the grading "at least A%" or "B-C%", to be reassessed in two or more years.

Degree of medical impairment. Examples of degree of impairment are: 7% for an unstable ankle joint, 5-20% for a shoulder with maximal flexion of 0-120°, 3-18% (in some cases more) for whiplash-related functional reduction, 37% for loss of one hand, 68% for total blindness, 99% for severe dementia. Mental effects and pain frequently occur with several functional reductions and are therefore included in the degree of impairment. If the pain or mental effect substantially exceed the normal occurrence of a specific functional reduction, a separate degree of impairment concerning the pain or mental effect can be assigned.

All injured persons with sustained functional reduction are assessed by consultant medical doctors who specialize in medical impairment. If the medical impairment is rated at least 10%, or if the injured person is not satisfied with the degree of impairment set, a public commission (the Swedish Road Traffic Injuries Commission) makes an additional assessment of the case. The commission appoints its own medical experts to ascertain that an injured person is assessed in the same way, regardless of which insurance company handles her/his case.

Material

During the years 1995 to 2001, 60,150 car crashes in Sweden with at least one injured person were reported to the insurance company Folksam. Out of these, 17,082 car crashes, mainly all car crashes from Folksam's two largest personal injury claim centres were selected. All fatally injured persons were excluded. Of the car crashes with reported injured persons, 3.7% were not found due to several reasons. They might simply have been transferred to another claims adjuster, they could initially have been wrongly reported as a crash with an injury, or they could have been wrongly filed in the archives. In total, 16,450 car crashes with 20,484 persons and 34,755 diagnoses were classified according to the AIS-2005 revision and included in the study.

All persons were followed for at least five years after the car crash, up to 30th June 2007; persons sustaining functional reduction judged by the medical doctors were coded according to AIS-2005, and degree of medical impairment was also noted.

RESULTS

Initial injury distribution

Table 1 shows the distribution of initially reported injuries. One injured person may have several injuries. The results are presented by body region, as used in AIS-2005, except for the region "external", which (as in the ISS body region "external") includes all lacerations, contusions, abrasions and burns, independent of their location on the body surface.

Table 1- Distribution of injuries by body region and AIS level

Body Region	AIS1	AIS2	AIS3	AIS4	AIS5
Head	753	118	67	28	8
Cervical Spine	15,139	70	19	2	0
Face	452	86	5	0	n.a.
Upper Extremity	385	439	6	0	n.a.
Lower Extremity and Pelvis	125	407	96	5	0
Thorax	192	380	141	7	0
Thoracic Spine	2,531	57	16	0	1
Abdomen	5	41	22	10	1
Lumbar Spine	2,688	104	13	4	0
External (Skin) and Thermal Injuries	10,314	15	1	2	0
Total	32,584	1,717	386	58	10

The vast majority of injuries are AIS1 or AIS2 injuries. As no fatally injured persons are included in the study, there are no AIS6 injuries and very few AIS5 injuries. Some combinations of body region and AIS level do not exist in the coding manual. These are marked not applicable (n.a.). Some combinations were not used at all.

There are numerous AIS1 injuries to the different parts of the spine and the body region "external". The most common single diagnoses are strain to the cervical spine AIS1 (15,139), followed by strain to the lumbar spine (2,688), and strain to the thoracic spine (2,531). Table 2 shows the distribution of the diagnoses that constitute the number of AIS1 external body region injuries, 10,314 cases in all.

Table 2- Distribution of AIS1 external body region injuries by type of injury and location

	Abrasion	Contusion	Minor Laceration	Thermal injuries
Scalp	72	954	343	
Neck	20	27	16	
Face	165	397	409	
Upper extremity	166	2,397	257	
Lower extremity	133	2,256	163	
Chest	19	1,713	12	
Abdomen	10	238	3	
Unclear location	67	403	60	14
Total	652	8,385	1,263	14

The most common type of AIS1 injury for the body region "external" is contusion of both the upper and lower extremities.

Permanent Medical Impairment Distribution

The lowest possible degree of impairment is 1%. Table 3 shows the risks on the 1%+ level for different body regions and AIS levels. This is the proportion of persons reporting an injury, as listed in Table 1, who sustain at least 1% permanent medical impairment.

The presented precision of the figures in Tables 3, 4 and 5 reflects the frequency of injuries as found in Table 1. The precision of the figures in Tables 3, 4 and 5 includes the first decimal in all AIS1 figures and the AIS2 figures up to 5%. The rest of the AIS2 figures and the AIS3, AIS4 and AIS5 figures up to 10% are rounded up/down to whole numbers, and the AIS3, AIS4 and AIS5 figures above 10% are rounded up/down to the nearest fifth percentage.

Some of the risks are by definition 100%. These involve diagnoses that are immediate and permanently disabling. This applies to AIS4 injuries to the cervical, thoracic and lumbar spine, where the sole diagnosis is incomplete cord syndrome (preservation of some sensation or motor function), and AIS5 complete cord syndrome (quadriplegia, C-4 or below, or paraplegia with no sensation). Also for AIS4 upper extremities, where the only diagnosis is amputation at the elbow or above, the risk of impairment is by definition 100 %.

Due to small numbers of initial injuries for some combinations of body region and AIS level (Table 1), the risk figures in Tables 3, 4 and 5 of these combinations are set to the same figure as the one for the next lower AIS level of the same body region. For instance, the body region "abdomen" AIS5 with one injury is assigned the same risk as "abdomen" AIS4: 20% on the 1%+ level (RPMI 1%+). AIS3 external, i.e. thermal injuries, is assigned the same risk as AIS4 external, due to the low number of injured persons.

Table 3- Risk of Permanent Medical Impairment (RPMI) on 1%+ level (i.e. 1-99%). Numbers in percent

	AIS1	AIS2	AIS3	AIS4	AIS5
Head	8.0	15	50	80	100
Cervical Spine	16.7	61	80	100	100
Face	5.8	28	80	80	n.a.
Upper Extremity	17.4	35	85	100	n.a.
Lower Extremity and Pelvis	17.6	50	60	60	100
Thorax	2.6	4.0	4	30	30
Thoracic Spine	4.9	45	90	100	100
Abdomen	0.0	2.4	10	20	20
Lumbar Spine	5.7	55	70	100	100
External (Skin) and Thermal Injuries	1.7	20	50	50	100

The highest risks of sustaining a permanent medical impairment on the RPMI 1%+ level for an AIS1 injury, occur to the cervical spine, i.e. neck strain (16.7%), and to the upper and lower extremities (17.4% and 17.6%). Examples of AIS 1 diagnoses of the extremities are joint sprains and distortions, tendon tears (except for knee and ankle), finger and toe injuries. In total, 2,525 persons (i.e. 65% of all those included in this study) sustained a permanent medical impairment after an AIS1 injury to the cervical spine.

For AIS2, the highest RPMI 1%+ figures are for injuries to all parts of the spine: cervical spine 61% risk, lumbar spine 55%, thoracic spine 45% and lower extremities 50%. For AIS2, thoracic and abdominal injuries show low risk of sustaining a permanent medical impairment: 4% and 2.4%. The risk of sustaining a permanent medical impairment after an AIS3 injury is at least 50%, except after injuries to the thorax or the abdomen, where the risk is 4% and 10%.

Table 4 shows the proportion of persons reporting an injury as listed in Table 1 who sustain at least 5% permanent medical impairment.

Table 4- Risk of Permanent Medical Impairment on 5%+ level (i.e. 5-99%). Numbers in percent

	AIS1	AIS2	AIS3	AIS4	AIS5
Head	5.0	12	45	80	100
Cervical Spine	9.7	40	55	100	100
Face	2.4	10	60	60	n.a.
Upper Extremity	4.2	10	65	100	n.a.
Lower Extremity and Pelvis	1.6	20	35	60	100
Thorax	0.0	0.5	0.7	15	15
Thoracic Spine	0.9	20	55	100	100
Abdomen	0.0	0.0	4.5	10	10
Lumbar Spine	1.6	25	45	100	100
External (Skin) and Thermal Injuries	0.2	7	50	50	100

Cervical spine injuries account for the highest risk of sustaining a permanent medical impairment after an AIS1 injury on the RPMI 5%+ level: almost 10% risk. For AIS1 head injuries there is a 5% risk. Of the AIS2 injuries, cervical spine injuries account for the highest risk: 40%. As on the RPMI 1%+ level, the body regions "thorax" and "abdomen" have a relatively low risk despite high AIS levels on the RPMI 5%+ level.

Table 5 shows the proportion of persons reporting an injury as listed in Table 1 who sustain at least 10% permanent medical impairment.

Table 5- Risk of Permanent Medical Impairment on 10%+ level. Numbers in percent

	AIS1	AIS2	AIS3	AIS4	AIS5
Head	2.5	8	35	75	100
Cervical Spine	2.5	10	30	100	100
Face	0.4	6	60	60	n.a.
Upper Extremity	0.3	3	15	100	n.a.
Lower Extremity and Pelvis	0.0	3	10	40	100
Thorax	0.0	0	0	15	15
Thoracic Spine	0.0	7	20	100	100
Abdomen	0.0	0.0	5	5	5
Lumbar Spine	0.1	6	6	100	100
External (Skin) and Thermal Injuries	0.03	0.03	50	50	100

A large number of AIS1 cervical spine injuries lead to lower degrees of impairment than 10%; therefore the risk is lower on the RPMI 10%+ level, namely 2.5%. About one third of AIS3 head and cervical spine injuries lead to at least 10% permanent medical impairment. The high risks of AIS3 for the body region "face" and "external" (thermal injuries) are based on very few cases.

Table 6 shows the risk of sustaining a permanent medical impairment, independent of the bodily location of the initial injury.

Table 6- Risk of Permanent Medical Impairment. Numbers in percent

	RPMI 1%+	RPMI 5%+	RPMI 10%+
AIS1	9.7	5.0	1.2
AIS2	31.6	12.5	3.3
AIS3	37.6	25.1	13.0
AIS4	63.8	60.3	53.4
AIS5	90.0	90.0	90.0
Total	11.2	5.7	1.6

At AIS1 level the risk of sustaining a permanent medical impairment of at least 1% (RPMI 1%+) is almost 10%, and 1.2% of the AIS1 injuries lead to at least a degree of 10% permanent medical impairment. Slightly more than one tenth, 11.2%, of all persons reporting an injury sustained at least 1% permanent medical impairment. The risk on the RPMI 5%+ level was 5.7% and the risk on the RPMI 10%+ level was 1.7%.

DISCUSSION

Considerable efforts are made to decrease loss of health due to road traffic accidents. It is important to have relevant measurements in order to identify priorities in injury prevention. Despite the knowledge that statistics based on police-reported non-fatal crashes are insufficient, the official statistics are still derived from this well-established source of information [SIKA, 2007]. The overall number of reported non-fatally injured persons in road traffic crashes is much lower than the actual number due to under-reporting by the police [Amoros, Martin, Laumon, 2006]. In addition, the severity of non-fatal crashes assigned by the police at the accident scene, i.e. whether those involved are considered severely or slightly injured, is mainly based on whether the injured person is expected to be admitted to hospital or not. The classification of injury severity only gives a rough picture of the true severity of the injury [Farmer, 2003].

As in most other countries, the official statistics in Sweden are based on police reports. Since 2003 an information collecting system, STRADA [Sjöö and Ungerbäck, 2007] is used in Sweden. In addition to police-reported accident information, those who have been injured in road traffic accidents who visit or are admitted to hospital are registered and classified according to AIS. To date, in 2008, about two thirds of all hospitals in Sweden use STRADA. By using statistics based on information from STRADA's

injuries classified at the hospital, combined with a predictive system of the risk of an initially injured person sustaining a permanent medical impairment, it is possible to better estimate the long-term consequences of non-fatal crashes.

An injured person's risk of sustaining a permanent medical impairment after a non-fatal crash as shown in this study differs greatly from the injury distribution in fatal crashes. In fatal crashes, head and thoracic injuries (excluding the thoracic spine) are frequent [Green, German, Nowak et al, 1994]. This study shows that the risk of sustaining a permanent medical impairment due to a thoracic injury AIS4+ (excluding spine), 30% risk on the RPMI 1%+ level, is rather low compared with other body regions on the same AIS level, and that half of the occurring thoracic impairments (excluding the spine) are of a rather low degree. For head injuries, on the other hand, there is a substantial medical impairment risk of 80 % on the RPMI 1%+ level, mostly with higher degrees of impairment. It seems that the major problem with AIS4+ thoracic injuries (excluding the spine) concerns the ability to survive the crash. A person surviving an AIS4+ thoracic injury (excluding the spine) usually recovers without functional reduction. This is also true for occupants who survive abdominal AIS4+ injuries.

The risks for the lower AIS levels, 1 and 2, are much lower than the risks for higher AIS levels, but because AIS1 and AIS2 injuries are so frequent, the majority of impairments have been sustained from the lower-level AIS injuries. Therefore it is important to take into account the impact of lower-level AIS injuries on public health. There are several interesting findings. Some AIS1 injuries show high risks, cervical spine (neck strain) and upper and lower extremities on RPMI 1%+ level (16-17%). When taking into account the fact that 15,139 persons report neck strain, the 16.7% risk means 2,525 individuals with persisting functional reduction; in other words, 65% of all persons in this study sustain a permanent medical impairment, and the risk on the RPMI 10%+ level, 2.5%, also involves a substantial number of persons. Other AIS1 injuries that account for a large number of impairments are those that involve the thoracic and lumbar spine, and the face and head. These are mainly associated with lower degrees of impairment, 1-9%, but AIS1 head injuries have the same high risk of 2.5% on the RPMI 10%+ level as AIS1 cervical spine injuries. Although the risks for the body region "external" are not very high, 1.7%, 0.2% and 0.03% on the different RPMI percentage levels, the high reported numbers (10,314) results in a substantial number of persons with impairments.

The presented RPMI risk tables of different degrees of impairment: 1%+, 5%+ and 10%+ (Table 3-5) show different risks and could lead to varying conclusions when used in order to identify priorities in injury prevention.

The total RPMI risk table of different AIS levels (Table 6) shows an increasing risk of permanent medical impairment with increasing AIS level, but as Tables 3-5 show, there are great differences between the risks for the body regions of a certain AIS level.

The data set used in this paper is not large enough to produce risks for permanent medical impairment assigned to single diagnoses. The impairment risk is therefore presented by body region and AIS level. The reason for separating the soft tissue injuries from their bodily location and putting all soft tissue injuries together in the body region "external" is because of the great difference in impairment risk between these injuries and other injuries on the same AIS level and the different body regions.

The included car crashes were mainly taken from two of Folksam's six personal injury claims centres. Although collision types and outcome might vary throughout Sweden, it is not likely that given an initial injury, a person's risk of sustaining a permanent medical impairment varies according to the area of Sweden in which a person resides.

As some of the risk figures represent combinations of AIS levels and body regions with low frequency, the risk figures on higher AIS levels are less accurate than the risk figures on lower AIS levels with more frequent combinations.

Some risk figures could be too low due to simultaneous occurrence of severe injury with less severe injury. For example, a person with a quadriplegia resulting from a cervical spine injury together with a crush injury of the leg is not assessed relative to the leg injury.

The Medical Impairment Scale used in this paper was constructed in consensus between medical specialists; it has been developed and improved since the early 1900s, but has still not been validated relative to long-term consequences measuring more subjective outcome such as pain and mental functional reduction. The Medical Impairment Scale should thus be validated for long-term consequences.

The RPMI is a tool that can be applied on data sets with initial injuries classified according to AIS-2005, in order to predict the number of persons sustaining functional reduction, as defined by the Medical

Impairment Scale used by Swedish insurance companies.

Further studies should investigate whether these predictive risk tables are valid for other road traffic victims and for car occupants of different ages and gender.

To develop an updated Rating System for Serious Consequences (RSC) [Gustafsson, 1985], supplementary studies of the risk of death correlated to ISS, classified according to AIS-2005, are needed.

CONCLUSIONS

Tables for the risk of sustaining a permanent medical impairment (RPMI) were developed and showed that:

- Almost 10% of all car occupants with AIS1 injuries sustain a permanent medical impairment. It is therefore important to include minor injuries leading to impairment when measuring health losses due to road traffic crashes.

- The highest risk of sustaining a permanent medical impairment associated with an AIS1 injury is in connection with injuries to the cervical spine and upper and lower extremities. In this data set, 65% of the impairments were the result of a cervical spine AIS1 injury.

- One third of those with AIS3 head and cervical spine injuries sustained a permanent medical impairment of at least 10%.

- Injuries to the thorax (excluding the thoracic spine) and abdomen are connected with the lowest risk of permanent medical impairment on all AIS levels and on all impairment levels (RPMI levels).

REFERENCES

AAAM. Abbreviated Injury Scale 2005. AAAM, Des Plaines IL, 2005

AAAM. Injury Impairment Scale (IIS). AAAM, Des Plaines IL, 1994

Amoros E, Martin JL, Laumon B. Under-reporting of road crash casualties in France. Accid Anal Prev. Vol. 38(4), pp 627-35, 2006.

Baker S, O'Neill B, Haddon W, et al. The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma. Vol.14, 187–196, 1974

Bradford M, Thomas P, Chambers D. Conversion of AIS85 to AIS90 and the application of the Injury Impairment Scale to Real-World Crash Data.38th Annual Proc, AAAM Conf., September 21-23, Lyon, France. pp159-175, 1994

Coons, SJ, Rao S, Keininger DL et al. A Comparative Review of Generic Quality-of-Life Instruments. Pharmacoeconomics, Vol. 17 (1), pp 13-35, 2000

Galasko CSB, Murray P, Hodson M, et al.Long Term Disability following Road Traffic Accidents. Transport and Road Research Laboratory, Research Report 59. Transport Research Laboratory, Crowthorne, United Kingdom, 1986.

Green RN, German A, Nowak ES, et al. Fatal injuries to restrained passenger car occupants in Canada: Crash modes and kinematics of injury. Accid. Anal. and Prev., Vol. 26(2), pp. 207-214, 1994

Gustafsson H, Nygren Å, Tingvall C. Rating System for Serious Consequences (RSC) Due to Traffic Accidents – Risk of Death or Permanent Disability. Proc. Of the 10th Technical Conf. On Experimental Safety Vehicles. Oxford, United Kingdom, pp.556-560, 1985

Farmer CM. Reliability of police-reported information for determining crash and injury severity. Traffic Inj Prev. Vol 4, pp 38–44, 2003

Hirsch AE, Eppinger RH.Impairment Scaling from the Abbreviated Injury Scale. DOT HS-806 648, NHTSA, US Department of Transportation, Washington D.C.1983

Hägg A, Kamrén B, v Koch M, et al. Folksam Car Model Safety Model rating 1991-92, ISBN 91-7044-132-4, Folksam Research, 10660 Stockholm, Sweden, 1992.

Hägg A, Krafft M, Kullgren A, et al. Folksam Car model safety ratings 2001, Folksam, Stockholm, Sweden, 2001

IRTAD. Traffic deaths per 100 000 population since 1970. International Traffic Safety Data and Analysis Group, 2007. Available online at http://cemt.org/IRTAD/IRTADPUBLIC/graphs/p139.pdf.

von Koch M, Nygren Å, Tingvall C. Validation of the Injury Impairment Scale.38th Annual Proc, AAAM Conf., September 21-23, Lyon, France. pp123-138, 1994

MacKenzie EJ, Damiano A, Miller T et al. The Development of the Functional Capacity Index. J Trauma. Vol 41, pp 799-807, 1996.

Miller TR. Costs and Functional Consequences of U.S. Roadway Crashes. Accid. Anal. and Prev. Vol. 5, No 25, pp 593-607, 1993

Nygren Å. Injuries to car occupants – Some aspects of the Interior Safety of Cars. Akta Oto-Laryngologica, Supplement 395, 1984

Osler T, Baker S, Long W. A modification of the Injury Severity Score that both improves accuracy and simplifies scoring. J Trauma. Vol 43, pp 922–926, 1997

Peden M, Scurfield R, Sleet D, et al., eds. World report on road traffic injury prevention. World Health Organization, Geneva, 2004.

SIKA. Vägtrafikskador 2006 (Road Traffic Injuries 2006). Statistik Vägtrafik 2007:30, Statens institut för kommunikationsanalys, Östersund, Sweden, 2007

Sjöö B, Ungerbäck A-C. Nytt nationellt informationssystem för skador och olyckor inom hela vägtransportsystemet. STRADA slutrapport. Swedish National Road Administration. Publikation 2007: 147. Borlänge, Sweden, 2007.

Sveriges Föräkringsförbund. Medicinsk invaliditet. Gradering av medicinsk invaliditet 2004. Sveriges Försäkringsförbund, ISBN 91-631-5403-X, Stockholm, Sweden, 2004

WHO. International statistical classification of diseases and related health problems. Tenth revision. ICD-10. Geneva, Switzerland 1990