BRIEF REPORT

Determining objective injury prevention priorities

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Injury Prevention 2006;**12**:347–350. doi: 10.1136/ip.2006.011494

Background and objective: Finite injury prevention resources make the establishment of prevention priorities essential. Toward this end, the US National Trauma Data Bank (NTDB) for 2000 to 2004 was accessed and four injury prevention priority scores (one previously defined and three new scores) were computed.

Methods: An injury prevention priority score (IPPS) was calculated based on the frequency of an injury mechanism and the median injury severity score. In addition, a mortality priority score (Mort-PS), a hospital charge priority score (Charge-PS), and a years of potential life lost (YPLL-PS) priority score were calculated for the 13 most common injury mechanisms.

Results: There was variability across the four scores, but motor vehicle traffic, firearm related, and fall injuries ranked high on all four of the priority criteria. Multiple criteria should be considered when assessing injury burden.

Conclusions: The methods presented here can help prioritize injuries and support more objective public policies.

Traumatic injury is a leading cause of death and disability worldwide.[1] In the USA, trauma is the leading cause of death and disability in the first decades of life, and the fourth leading cause of death overall.[2] Injury related medical costs and productivity losses in the USA exceed $400 billion annually.[3] Injury prevention efforts are thus paramount for reducing the overall burden of trauma related illness. As in other countries, however, resources to devote to injury prevention are limited and thus prioritization is essential.

Establishing injury prevention priorities can be imprecise. Various injury severity markers have been defined to help gauge the significance of different injury mechanisms. These markers can generally be grouped into four types: mortality related indices (for example, mortality rate; years of potential life lost (YPLL)); morbidity related indices (such as the abbreviated injury scale); composite measures combining mortality and morbidity (for example, quality adjusted life years (QALY)); and monetary costs (for example, health system costs).[4] A common approach is to use only a single criterion, but to rank and thereby differentiate injury mechanisms in terms of priority.[5–8] In contrast, Hendrie and Miller recommend that a combination of indices must be considered to assess injury prevention priorities most accurately.[4]

Haider *et al* present a method for prioritizing injury mechanisms in a fashion that accounts for the frequency of an injury mechanism in a given population as well as the severity (that is, anatomic damage) of each injury mechanism, and suggest that the method can be used to prioritize injury mechanisms according to other criteria as well.[5] Following this suggestion and the recommendation of Hendrie and Miller, the goal of our study was to prioritize injury mechanisms according to four distinct indices of injury burden and present the findings in a visual format to aid interpretation. Having found that this method generates information that is at once comprehensive and easy to disseminate to key audiences, including policymakers, we now describe the method so that it can be readily applied by other investigators to help prioritize injury mechanisms according to their relative burden on any given society or health system.

METHODS

Data for the period 2000 to 2004 were obtained from the National Trauma Data Bank (NTDB),[9] a surveillance system administered by the American College of Surgeons to capture information on patients treated at trauma centers across the USA. Participation in the databank by trauma centers has risen to include 565 trauma centers in 45 states, with Level I and Level II trauma centers accounting for the majority of hospitals. Over two thirds of Level I and over half of Level II trauma centers are estimated to participate in the NTDB.[10] In addition to patient demographics, the NTDB documents injury mechanism (ICD-9 E-code), injury severity score (ISS),[11 12] hospital charges, and vital status at discharge.

With these data we computed priority scores for each of the 13 most frequent injury mechanisms (using groupings defined elsewhere[13]) as a way to enable ranking of the mechanisms according to four selected criteria of potential injury burden. The Injury Prevention Priority Score (IPPS) was computed as a marker of injury severity (that is, anatomic damage). Defined by Haider *et al*,[5] IPPS is a composite measure that balances the influences of frequency and severity (based on ISS) of each injury mechanism. Essentially, IPPS is calculated by computing a frequency count for each injury mechanism and transforming the counts into *z* scores[14] (which have a mean of 0 and standard deviation of 1), and also computing the mean or median ISS for each injury mechanism and transforming those values into *z* scores (these two sets of *z* scores will indicate the relative frequency and relative severity, respectively, of each injury mechanism). The two *z* scores for each mechanism are summed, and then the SD of that set of *z* score sums is calculated. Next, a new list of *z* scores is calculated by dividing each *z* score sum by the SD of the *z* score sums. Finally, the IPPS is derived by calculating a T score for each mechanism, where $T = 50+10z$. Thus IPPS values have a mean of 50 and an SD of 10.

This same methodology that Haider *et al*[5] used to compute IPPS was then applied to derive a hospital charge priority score (Charge-PS), which reflected the relative frequency of each mechanism in conjunction with the median charge per patient of acute care associated with treatment (adjusted to the value of $2004[15]). Also, a years of potential life lost priority score (YPLL-PS) was computed to reflect the relative frequency of fatalities in each mechanism in conjunction

Abbreviations: Charge-PS, hospital charge priority score; IPPS, injury prevention priority score; ISS, injury severity score; Mort-PS, mortality priority score; NTDB, National Trauma Data Bank; YPLL, years of potential life lost; YPLL-PS, years of potential life lost priority score

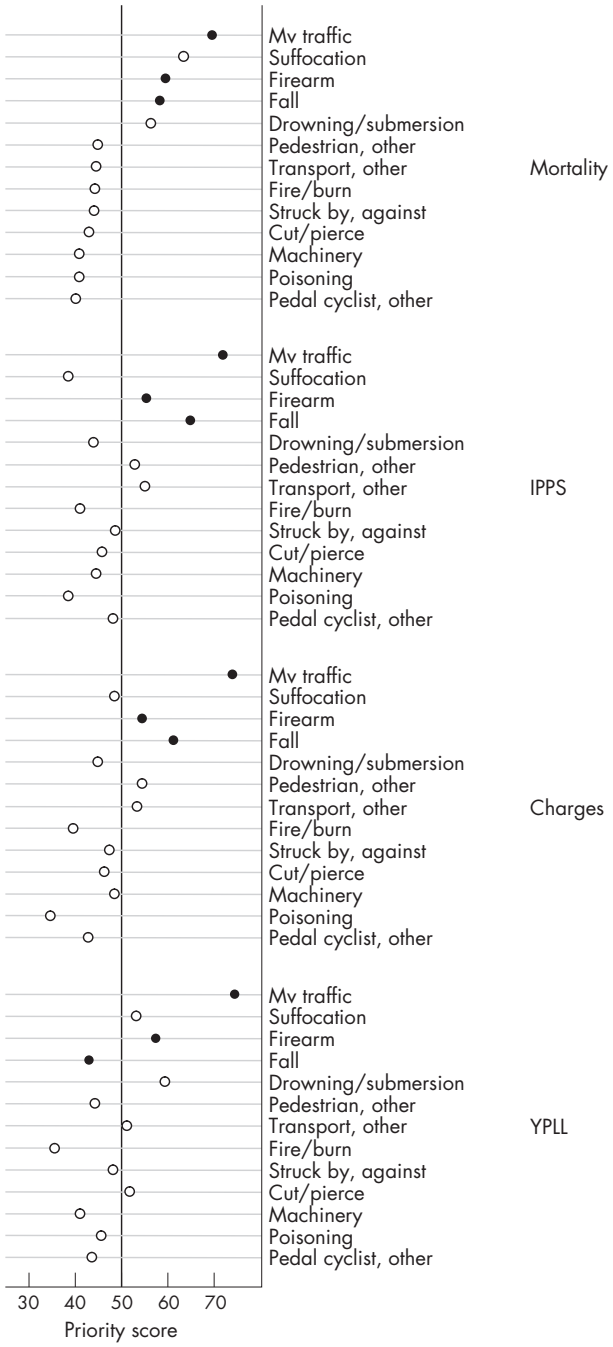

Figure 1 Injury prevention priority score rankings by four priority criteria: US trauma centers, 2000–2004. Filled symbols denote injury mechanisms that received a high priority score (defined as being ranked fourth or higher) on at least three of the four priority criteria.

with the number of years of potential life lost among deceased patients. The life table method was used for the YPLL calculations,[16] which involved calculating the years of potential life lost for each decedent by subtracting each decedent's age at death from the life expectancy age[17] of persons of the same age and sex who were alive in 2000. Finally, a mortality priority score (Mort-PS) was computed to reflect the relative frequency of each mechanism and its associated in-hospital mortality risk.

Mechanisms were then arranged in rank order and the results were plotted to enable comparisons across the four types of injury priority scores. To aid the comparison of

Table 1 Incidence and characteristics of 13 injury mechanisms presenting to US trauma centers, 2000–2004, and priority scores and priority rankings by injury mechanism

	Incidence and characteristics						Priority scores and rankings									
							Mortality		Injury severity		Hospital charges		Years of life lost			
Mechanism	n	Median age (y)	Median ISS	Median charges	Median YPLL	Mortality (%)	Mort-PS	Rank	IPPS	Rank	Charge-PS	Rank	YPLL-PS	Rank
Motor vehicle traffic	378 029	32	9	$15 941	37	5.0	69.7	1	72.0	1	74.0	1	74.6	1
Suffocation	1314	28	1	$12 754	48	23.0	63.4	2	38.5	12	48.5	6	53.3	4
Firearm	53 146	26	9	$14 484	48	16.2	59.5	3	55.5	3	54.4	4	57.4	3
Fall	237 500	53	9	$12 922	10	3.5	58.4	4	64.9	2	61.1	2	42.9	11
Drowning/submersion	945	20	4	$10 777	56	16.5	56.2	5	43.9	10	44.9	10	59.4	2
Pedestrian, other	3 100	32	9	$15 936	36	5.9	44.8	6	53.0	5	54.4	3	44.3	9
Transport, other	45 151	29	9	$14 240	42	2.9	44.5	7	55.1	4	53.5	5	51.2	5
Fire/burn	17 511	28	2	$7412	23	4.6	44.4	8	41.2	11	39.6	12	35.5	13
Struck by, against	61 962	30	5	$10 367	35	1.5	44.1	9	48.8	6	47.3	8	48.2	7
Cut/pierce	40 574	31	4	$10 477	42	1.9	43.0	10	45.9	8	46.4	9	51.8	6
Machinery	12 221	40	4	$12 442	31	1.8	41.0	11	44.5	9	48.5	7	41.2	12
Poisoning	1041	32	1	$5201	38	2.5	41.0	12	38.5	13	34.7	13	45.7	8
Pedal cyclist, other	13 934	17	6	$9277	34	0.9	40.1	13	48.2	7	42.8	11	43.6	10

Note: data are based on trauma centers participating in the NTDB surveillance system.
Charge-PS, hospital charge priority score; IPPS, injury prevention priority score; ISS, injury severity score; Mort-PS, mortality priority score; NTDB, National Trauma Data Bank; y, years; YPLL, years of potential life lost; YPLL-PS, years of potential life lost priority score.

rankings visually, the injury mechanisms are listed in the same order in each plot; the ordering reflects decreasing priority score on the mortality criterion (Mort-PS). Symbols presented as filled were used to indicate those injury mechanisms that received a high priority score (defined as being ranked fourth or higher) on at least three of the four priority criteria. The study was granted an exempt status by the institutional review board of the University of Pennsylvania.

RESULTS

For the 2000 to 2004 period of review, 952 242 patients were entered into the NTDB database including 888 319 injured by the 13 most common mechanisms. The mortality risk and the median patient age, median ISS, median hospital charges, and median YPLL associated with each injury mechanism are shown in table 1. Motor vehicle traffic injury, which was the most frequent injury mechanism treated at NTDB trauma centers over the study period (n = 378 029), ranked as the highest injury prevention priority on all four injury prevention priority criteria (table 1; fig 1). Suffocation, which was a relatively infrequent mechanism (n = 1314) but was associated with the highest mortality probability (23.0%), ranked second on the mortality criterion, and firearm related injury ranked third on the mortality criterion.

However, motor vehicle traffic related, firearm related, and fall related injuries were the only mechanisms that had high rankings (defined as being ranked fourth or higher) on at least three of the four priority criteria.

Additional high priorities based on injury severity included pedestrian and transport related injuries, both of which received high rankings on the hospital charge criterion as well. After motor vehicle traffic related injury, the injury mechanisms ranked as the highest priorities in terms of years of potential life lost were drowning/submersion, firearm related injury, and suffocation, respectively. Thus there is considerable variability between mechanisms when contrasting the prevention priority criteria, but several mechanisms emerge that rank high consistently across criteria.

DISCUSSION

Because injury prevention resources are finite, their apportionment must be based on demonstrated public health needs. Efficient allocation strategies should consider a variety of factors that can be used to match resources and priorities.[4] Our results indicate, however, that prevention priorities for injury in the USA may vary, based on the score criterion used. From a clinical perspective, measures of injury severity or mortality might best assess injury burden. From a societal perspective, measures of long term impact (for example, YPLL-PS) or the financial burden (such as Charge-PS) might be best. The advantage gained by critically considering multiple criteria is a more complete appraisal of the burden of an injury mechanism than would be gained by considering a single criterion alone.[18]

Overall, motor vehicle traffic related injuries ranked as the top injury prevention priority on all four criteria that we analyzed, owing in part to their high incidence. Thus a heavy allocation of prevention resources to this public health problem would appear justified based on the US trauma center population. Additional injury mechanisms consistently ranking highly included firearm and fall related injuries. Hendrie and Miller found that motor vehicle traffic related injuries and falls also ranked among the top three mechanisms on several other criteria.[4] In terms of societal costs and non-fatal hospital admissions, however, they found that firearm related injuries were not highly ranked.

It is important to consider the challenges that arise when trying to identify injury prevention priorities, and the resulting limitations of such efforts.[18] In our analysis, the NTDB included only a subset of trauma centers in the USA. Therefore, the results will accurately represent the injury prevention priorities in the entire US trauma center population only if the relative frequency (and relative mortality, severity, cost, and years of potential life lost) of injury mechanisms in the participating centers is similar to that in all trauma centers. Beyond this, the validity of the results will be subject to the quality of the NTDB data.[19] More generally, although use of NTDB data enabled the relative burden of injury mechanisms on the trauma healthcare system itself to be quantified, it is equally important to determine how trauma priorities rank while taking into consideration injury victims who die before receiving treatment at a trauma center, or who are treated in hospitals that are not accredited trauma center sites; neither type of victim was represented in the present analysis. Also, instead of classifying injuries according to mechanism (for example, ICD-9 mechanism), an alternative approach could be to classify injuries according to manner/intent (for example, suicide or unintentional), which would enable a different type of evaluation of the burden of injury. Yet another way to expand upon the methods used here is to compute priority scores for other criteria, such as the long term economic costs involved or quality adjusted years of life. Whatever criteria are used, we suggest that the priority score method can help make priority determinations objectively.

An advantage of the ranking method applied here is that it gives relative frequency and relative severity (in terms of injury severity, mortality risk, or other criterion) equal weighting when deriving a priority score.[5] Also, an IPPS or other priority score will have the same mean and standard deviation across injury mechanisms in a given trauma registry; therefore, another advantage of the priority score method is that allows the relative importance of a particular injury mechanism to be compared across sites and across time.[5] Even so, an analysis may produce findings in which a highly frequent, low severity mechanism and a rare, high severity mechanism are assigned the same priority score. Therefore, instead of focusing solely on rank ordered priority score results, it remains important to be aware of the nature of the underlying injury phenomena being studied, including basic information for each injury mechanism such as total incidence and treatment costs overall.

The injury mechanisms that are found to be priorities based on an analysis of a large geographic area (for example a country) may not be the priorities that exist in smaller constituent areas such as states, counties, or at a given trauma center. Geographic areas that are similar according their standing on a given classification scheme (such as a rural–urban continuum[20]) may have different injury priorities which will be a function of demographics (such as the age distribution) and the environment (the characteristics of the

Key points

- An injury prevention priority score was calculated based on the frequency of an injury mechanism and the median injury severity score. A mortality priority score, a hospital charge priority score, and a years of potential life lost priority score were also calculated for the 13 most common injury mechanisms.
- There was variability across the four scores, but motor vehicle traffic, firearm related, and fall injuries ranked high on all four of the priority criteria.
- Multiple criteria should be considered when assessing injury burden.

streets and highways).[5] In addition, injury prevention priorities for a given location may differ across age groups and may change as the population ages. Thus policy decisions about injury priorities should be tailored to specific periods and places.

Efforts to prioritize injury events and allocate limited prevention resources will ultimately benefit from additional application of the prioritization and presentation methods used here. These scoring methods make a clear case for strategically managing resources to produce focused interventions that are aimed at an objectively determined short list of leading injury priorities.

ACKNOWLEDGEMENTS

We thank Drs Hank Weiss, Brendan Carr, and John Holmes for helpful comments on a previous version of this work presented at the 2005 Annual Meeting of the American Public Health Association. The work was conducted under funding from the Joyce Foundation.

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Accepted 29 May 2006

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LACUNAE

Dozens injured as cheese roll goes crackers

Twenty five people were injured at an annual cheese-rolling competition in which daredevils chase giant cheese wheels down a steep slope in western England. Dozens took part in the bizarre event at Cooper's Hill in Brockworth, Gloucestershire, before a crowd of about 3000 cheering spectators. They raced for 200 m down the slope after wheel-shaped Double Gloucester cheeses, decorated in a blue and red ribbon. Many slipped, somersaulted, and tumbled their way to the bottom during five bone-crunching races over two hours. Of the 25 people hurt, 12 were spectators, one of whom was hit by one of the hard, 4 kg, dinner plate sized cheeses used in each race, but only two people were taken to hospital for further assessment. The organisers said the number of injuries was comparatively low. ''We usually average around 30 to 40 people who need treatment'', said Jim Jones, operations training manager for St John Ambulance. ''The most serious injuries this year appear to be a dislocated finger and a possible fractured ankle.'' The unusual event has been celebrated for centuries and is thought to have its roots in a heathen festival to celebrate the return of spring.

Contributed by Ian Scott. From *The Australian*.