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16. Abstract

On June 15 and 16, 1998, NHTSA sponsored a conference to discuss the current state of knowledge of injury outcomes, with an emphasis on motor vehicle crash injuries. The purposes of the conference were to share the current state of knowledge in measuring injury outcomes with the agency's partners in industry, government and academe, and to provide the agency with information from which an agenda for further work could be developed.

Presentations were made on health status measures, QALYS and DALYS, societal costs, functional capacity, pediatric functional capacity, behavioral effects, current status of ICD-10 CM, sources of payments, data linkage and a summary of the international conference on Measuring the Burden of Injury held in the Netherlands in May, 1998. Three breakout sessions provided the audience an opportunity to discuss the issues and express their views concerning economic measures, behavioral effects and data. Participants also provided written comments.

A synthesis of the conference results suggest the following topics for inclusion in any agenda for future work on injury outcomes: update the economic costs of injury, continue development of the Functional Capacity Index and its derivatives, develop a method for quantifying psychosocial outcomes suitable for policy analysis applications, develop aggregated data bases derived from linked data, develop improved methods for estimating the outcome of multiple injuries, improve the understanding of the relationship of actual injury outcomes to those implied in tests using cadavers, dummies, test devices and mathematical modeling, and develop an understanding of the relationship among economic, physical and behavioral outcomes.

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SUMMARY

On June 15 and 16, 1998, NHTSA sponsored a conference to discuss the current state of knowledge of injury outcomes, with an emphasis on motor vehicle crash injuries. The purposes of the conference were to share the current state of knowledge in measuring injury outcomes with the agency's partners in industry, government and academe, and to provide the agency with information from which an agenda for further work could be developed.

Presentations were made on health status measures, QALYS and DALYS, societal costs, functional capacity, pediatric functional capacity, behavioral effects, current status of ICD-10 CM, sources of payments, data linkage and a summary of the international conference on Measuring the Burden of Injury held in the Netherlands in May, 1998. Three breakout sessions provided the audience an opportunity to discuss the issues and express their views, covering economic measures, behavioral effects and data. Participants also provided written comments. This report summarizes the presentations, the breakout sessions and the participant's comments.

A synthesis of the conference results suggest the following topics for inclusion in an agenda for future work:

Economic Outcomes
Methods - Methods are well developed.
Applications - Update economic costs of injury, with an emphasis on medical costs, the costs of rehabilitation, sources of payments, and costs to families.

Physical Outcomes
Methods - Continue development of the Functional Capacity Index and its derivatives.
Applications - Develop estimates of the physical outcomes of injury.

Behavioral Effects
Methods - Develop a model of psychosocial outcomes that can be used as a basis for development of methods for quantifying them particularly for policy analysis applications.
Applications - Develop estimates of the psychosocial outcomes of injuries.

Data Issues
Methods - Methods for linking data are well developed.
Applications - Develop aggregated data bases derived from linked data, utilize linkage techniques to develop longer term trends in injury outcomes.

General Topics
Methods - Methods for estimating the outcome of multiple injuries are not well developed and effort to improve them is desirable.
Applications - Improve the understanding of the relationship of actual injury outcomes to those implied from tests using cadavers, dummies, and test devices as well as from mathematical modeling; determine the relationship among economic, physical and behavioral outcomes.

INTRODUCTION
William Walsh, Associate Administrator for Plans and Policy, NHTSA

No one here today needs to be told that injuries are a major public health problem. According to the National Center for Health Statistics[1], more than 59 million people were injured in the United States in 1995. These injuries resulted in 37 million emergency department visits, 2.6 million hospitalizations and just under 148,000 deaths.

However, the fact that one in seven Americans are injured seriously enough to visit an emergency department during the year is just the beginning of the story. We are interested in what changes occur in their lives as a result of the injury, that is, what is the injury outcome. For those with minor cuts and bruises the outcome may be as simple as being in pain for a while, spending a few hours at a hospital getting patched up, and then going on with their lives. At the other end of the severity scale, the seriously injured person could spend several days in the hospital, weeks in rehabilitation, and a lifetime of impairment. When the person injured is someone we care about we have to contend with the concern and worry and possibly grief over their condition. Even if all of the people injured are just faceless statistics to us, we are all still affected. Our insurance premiums are higher than they otherwise would be in order to cover the costs of uncompensated care and our taxes are higher than they would otherwise be in order to provide the funds for public assistance for those who can no longer work and therefore can't pay their share of taxes.

People injured in motor vehicle crashes are a particularly important sub-set of the total injured population. Unlike some injury causes, motor vehicle crash injuries often result in long term impairment. At NHTSA, it's our job to try to reduce the incidence of all injuries, especially those with the greatest effect. So, in order for us to do our job, it is very important that we be able to quantify injury outcomes. We need to have objective methods for resource allocation, choosing among alternative program or policy ideas, or determining if the agency should issue a regulation that will have an impact on the motor vehicle manufacturers and thus on the American people. Deciding about interventions focused on fatalities is fairly simple - we can generally rely largely on a body count. With injuries, however, we need considerably more sophisticated ways of comparing alternatives. This has resulted in the agency being involved in efforts to improve the way injury outcomes are measured. This conference is part of that effort.

We organized the conference with three purposes in mind:

- Share knowledge on injury outcomes,
- Foster communication among those active in the field, and
- Develop an agenda for injury outcomes research.

Since measuring injury outcome requires a multi-disciplinary approach we have invited speakers from a number of different backgrounds. It also is important that we hear your thoughts to help us develop our agenda for the future.

I want to welcome all of you and look forward to a successful meeting.

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1. National Center for Health Statistics, Health, United States 1996-1997 and Injury Chartbook, Hyattsville, Maryland 1997

OVERVIEW

Stephen Luchter, Senior Policy Advisor, Office of Plans and Policy, NHTSA

Figure 1 shows the motor vehicle injury and fatality rates from 1988 through 1996 based on NASS GES and FARS respectively. Figure 2 shows a steady rise in the number of injuries relative to the number of fatalities during this period. In fact, the number of injuries relative to the number of fatalities was 15 percent higher in 1996 then it was in 1988, increasing at an average compound rate of nearly 1.8 percent a year. These data indicate that motor vehicle injuries are becoming an even more significant portion of the overall motor vehicle safety picture.

So, with limited resources, it's more important than ever that we focus our efforts on the most important injury problems. But, how to define what's most important? Well, we see injury outcome measures as a critically important tool for helping us decide. We want to be sure that we have the most complete information available on injury outcomes to help us prioritize our efforts. And that's why it was decided to have this conference. We wanted to hear from people who are doing some of the cutting edge research in this area, and we also wanted to hear from people who were applying the results of this research to their problems to help us identify gaps in the knowledge base that we should consider for a future a future research agenda.

Figure 3 shows one possible model of injury outcomes. It shows that injuries affect not only the injured person, but their families and communities as well, and that there are at least three kinds of injury outcomes that are important: economic, physical and psycho-social or behavioral. We also believe that injury outcomes are not a static value, but vary with time as well as the age and sex of the injured individual.

We used this model to structure the conference. Today's presentations will focus on discussions of various parts of this model - where we are and what needs to be done to fill in some of the gaps. We start with the clinical measures of injury outcome and how they relate to injury, followed by a presentation on the QALY and DALY concepts. Next we focus on the economic measures of outcome. After lunch we will hear about the development of the Functional Capacity Index and then about the current status of measures of measuring behavioral and psychosocial effects of injury. We'll end the day with a report on the development status of the ICD-10, focused on changes we can expect with respect to ICD-9.

Tomorrow we will shift gears and talk about some important applications. We'll hear a status report on some work that's been done recently on improving our knowledge of who pays for injuries and why this topic will become very important in the near term. Then we'll hear about a tool that has been meeting increasing success, linking data from several sources in order to extract the most information as possible out of a given incident. This will be followed by a presentation on the international meeting that was held last month on measuring injury outcomes and what it might mean to us here, coupled with a summary of one of the presentations at that conference on the development of a pediatric version of the functional capacity index. We'll then ask for your input, dividing into three breakout groups to help identify gaps in the current knowledge base. The groups will focus on economic measures, psycho-social measures and data. We want to be sure we have input from a broad slice of the field as we develop our future research plans. We'll end up with reports of the breakouts and open discussion.

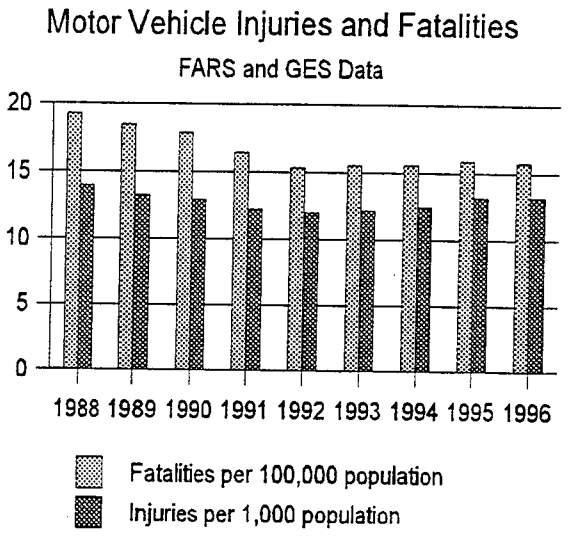


Figure 1

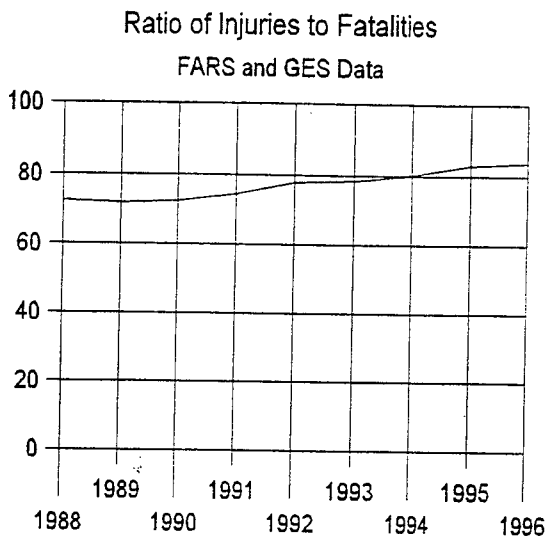


Figure 2

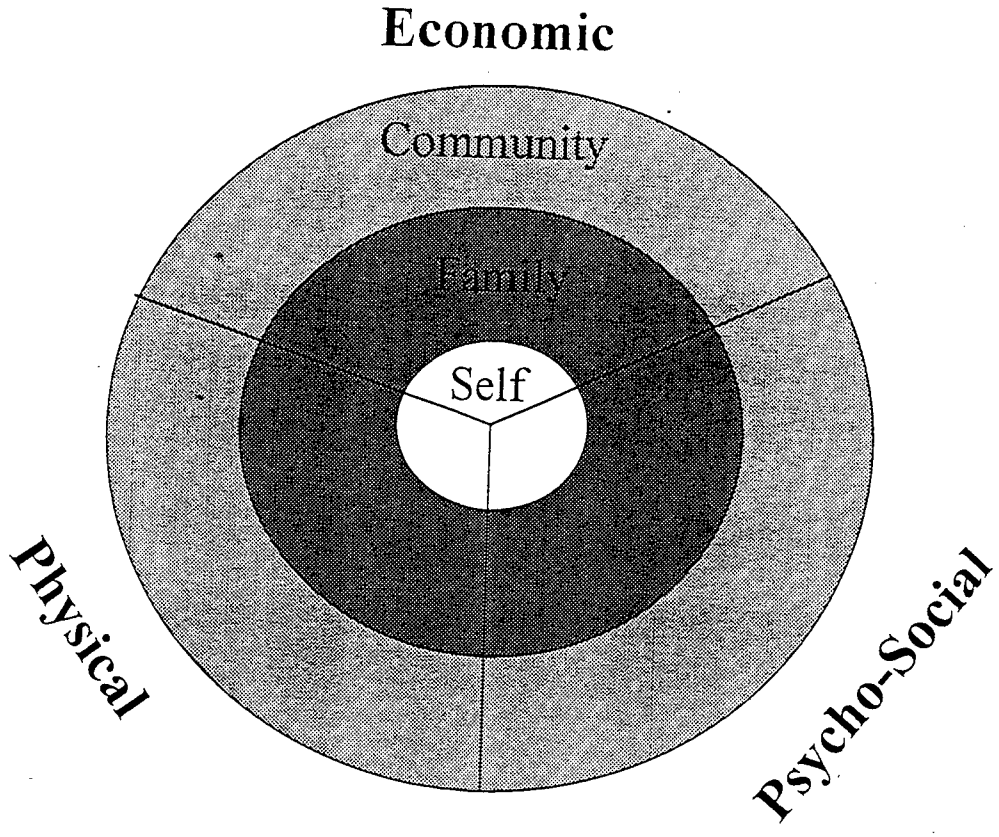


Figure 3

PATIENT ORIENTED HEALTH STATUS MEASURES

Albert Wu, Associate Professor of Health Policy and Management and Medicine, The Johns Hopkins University

Outcomes research is a comprehensive approach to determining the effects of medical care using a variety of data sources and measurement methods. Outcomes research includes the rigorous determination of what works in medical care and what does not, and how different providers compare with regard to their results on patient outcomes. A number of factors are motivating increasing emphasis on outcomes research, including rising health care costs, changes in the organization and financing of care, unexplained variation in practice patterns, limited information about effects of treatments and increased adoption of the model of shared patient and physician decision-making.

There are a number of conventional clinical measures of outcome, including mortality, disease or treatment complications, pathology, physiologic or laboratory abnormalities, deformity and signs and symptoms. There are also a number of ways of looking at outcomes, including the clinical perspective, the patients perspective (which may include subjective health status, quality of life or satisfaction) or an overall societal perspective (which may include utilization and cost).

It is important to define certain terms, as many are used interchangeably, such as health, (subjective) health status, functional status, quality of life and health-related quality of life. The World Health Organization defines health as "a state of complete physical, mental, and social well-being, and not merely the absence of disease and infirmity". Based on the work of Marilyn Bergner, we can consider a number of components of health status, including the genetic foundation, the biochemical, physiologic, or anatomic condition, the functional condition, (which includes performance of all the usual activities), the mental condition and the health potential.

Quality of life has been defined by Donald Patrick and Pennifer Erickson as "the entire range of human experience, states, perceptions and spheres of thought concerning the life of an individual or a community. Both objective and subjective, quality of life can include cultural, physical, psychological, interpersonal, spiritual, financial, political, temporal and philosophical dimensions. Quality of life implies a judgment of value placed on the experience of communities, groups such as families, or individuals. Health-related quality of life includes the aspects of health that are directly experienced by the person including physical functioning, social and role functioning, mental health and general health perceptions."

Health status and quality of life can be affected by personal, social and familial, societal, environmental, and health system factors, however, these factors are **not** themselves health or quality of life. It is convenient to think that health and quality of life "ends at the skin."

How do you measure dimensions of Quality of Life? Measurement itself is the process of applying a standard scale to a variable. There is no standard scale for quality of life, so there is a need to be specific about what we want to measure. In general we have to assemble several indicators which approximate the concept. This allows us to create scale scores by combining responses to questions. In any case it is important to include consideration of measurement error. Measurement of *any* phenomenon always contains a certain amount of chance error.

Every observed score on any measuring instrument is made up of 2 quantities: a true score, and some random error

$$X=T+E$$

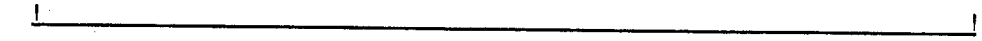
where

X represents observed score
T represents true score
E represents random error

Patient reports and ratings can be reliable and valid. In fact, they may be more reliable than commonly used clinical measurements such as serum cholesterol or interpretations of x-ray films. They are related in expected ways to other sources of information and they can predict important future events, including clinical outcome, hospitalization, job loss, and death. They can also detect differences between treatments and changes over time.

There are a number of advantages of quality of life assessment. Such assessments can be comprehensive, integrative, sensitive, policy relevant and important to patients. There are a number of scaling methods for measuring health related quality of life and a number of scales that can be used to assess it. The scaling methods include continuous judgment, which can be based on visual analog scales, and categorical judgment. Categorical judgment includes both nominal and adjective rating scales. Among the nominal scales are Activities of Daily Living (ADL) and the Sickness Impact Profile (SIP) which are based on a yes or no response. The adjective rating scales include the Medical Outcomes Study Short Form 36 (SF-36) and the Functional Independence Measure (FIM).

Visual Analog Scales consist of a line of fixed length, usually 10 centimeters, with anchors at the ends. There are no words describing intermediate positions. This approach is potentially a ratio scale. For example, a visual analog scale to assess pain would look something like this:



No Pain Worst Possible Pain

The Katz Index of Activities of Daily Living (ADL) is useful for description and screening. It is based on performance of "primary biological functions." The six original activities are bathing, dressing, toileting, transferring, continence and feeding. These functions are observer determined by whether the patient is assisted or functions independently.

In adjective rating or Likert-type scaling responses are assigned numerical values, with the severity or extent judged using several ordered responses. Responses are then combined to form a summated rating scale.

The Medical Outcomes Study was a 4 year observational study undertaken to determine how specific components of the health care system affect the outcomes of care. The study looked to determine the relationship of patient outcomes to differences in system, clinician speciality, intensity and style and to develop more practical tools for routine monitoring patient outcomes in medical practice.

The SF-36 consists of 36 questions that measure physical, social and role limitations, general mental health, vitality and perceptions of health in general. The form is self-administered,

but can also be used in phone or interview modes. There are standardized (different) 3-6 point response scales. Scaling and scoring is accomplished by taking the sum of item scores, recoding and reversing and using linear conversion to a 0 - 100 scale. Eight subscale scores are developed, as well as summary scores for physical and mental components. A sample SF-36 question is shown in box 1.

Box 1

During the past month, how much of the time have you had enough energy to do the things you wanted to do?
- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time

Another widely applied health status measure is the Sickness Impact Profile or SIP, which is intended to measure "sickness", not disease. This scale assess the impact of sickness on everyday activities. It consists of 136 items intended for yes answers only. The scale can be self or interview administered. The SIP is performance based, measuring 12 categories. These are ambulation, mobility, body care and movement, social interaction, alertness behavior, emotional behavior, communication, sleep and rest, eating, work, home management, and recreation and pastimes. Some sample SIP items are shown in box 2.

Box 2

Emotional behavior	I act nervous or restless
Social interaction	I am going out less to visit people
Mobility	I am not going into town
Ambulation	I walk more slowly
Alertness behavior	I do not keep my attention on any activity for long
Work	I am not working at all
Recreation/pastimes	I am doing fewer community activities

SIP scores are the percent of total possible dysfunction. Scores are determined by summing the scale values of all items checked, dividing by the sum of scale values for all items, and multiplying by 100. Scores can be anywhere from 0 to 100 with higher values indicating a worse condition. Scores are developed for the entire scale, for each category, and for the psychosocial and physical dimensions.

A scale developed to measure the degree of disability is the Functional Independence Measure (FIM). It is used in inpatient medical rehabilitation facilities and is part of the Uniform Discharge System (UDS), which lists impairment, demographics, diagnosis and length of stay. The FIM consists of 18 items that measure self-care, sphincter control, mobility, locomotion, communication, and social cognition. The scale is rated by a therapist using a 7-level scale of disability, where total assistance is given a value of 1, and complete independence is given a value of 7. Administering the FIM takes 10 minutes.

FIM scoring is intended to produce total score as well as measuring two dimensions, motor and cognition. There are cut-off scores indicating low independence (35) and high independence (60). Comparative data are available. The FIM is used at admission and discharge from a rehabilitation facility. As part of the Uniform Discharge System the data are used for program evaluation, outcomes research and client tracking.

When selecting a health status measure there are a number of considerations. General guidance can be gained from the Medical Outcomes Trust Review Criteria as shown in box 3.

Box 3

Purpose	Evidence of reliability and validity
Conceptual Basis	Evidence for responsiveness
Content	Burden
Range	Language/Culture

When considering the appropriateness of a particular health status measure there are a number of factors to weigh. The measure must be appropriate to the question or issue of concern. There must be a correspondence between the content of the measure and the goals of the study. To be sure of these, it is always necessary to examine the questionnaire itself and determine that the scales go into sufficient depth. The range in the study sample and the instrument must be in agreement, and there is a need to consider the level of aggregation of scores.

One way to classify instruments is into two types, those that are generic in nature and those that are disease specific. The generic measures can be used across populations and are generally better tested. Specific measures, which can be specific to a particular disease, treatment, population or study at least theoretically are more sensitive to differences in change of condition.

When considering the evidence of the relevance to a particular population the issues are reliability and validity. There must be face validity, the content must relate to the population, the instrument should perform in ways consistent with a set of hypotheses (construct validity) and the instrument must be responsive to change in the population's health state.

Validity is the extent to which an instrument measures what it is supposed to measure. There is no precise point at which a measures is considered valid, but rather the question is, valid for what? Validating a health measure is the process of accumulating different kinds of evidence to determine the most appropriate interpretations of a health score.

The practical considerations include the mode of administration, the time it takes to administer, the language used, the respondent burden and the availability of supporting materials.

A particular concern with any health status measures is what to do if the person cannot respond to the instrument. In that case it is necessary to use proxy respondents. These proxies are often available when the subject is not, and often are the effective decision maker. There is evidence that the reliability of proxies is greater for observable behaviors, but the proxies may be systematically biased tending to underestimate quality of life and pain. This bias appears to decrease with increased care-giving.

Applications of quality of life assessments includes their use in research, for both clinical trials and cohort studies, as well as directly in clinical applications for screening, decision-making, tracking over time and outcomes management.

QALYS AND DALYS

Anne Haddix, Chief Economist, Centers for Disease Control

QALYS and DALYS are examples of preference based multiattribute utility measures of health status that capture the effects of morbidity and mortality. The use of utility measures allows comparison of disparate outcomes, changes in quantity of life (mortality) and quality of life (morbidity) and timing effects. Utility measures can be used to measure the burden of disease and injury and to conduct cost effectiveness studies.

There are two categories of utility based health status measures, direct and indirect. Although time consuming and complex, direct measurements are appropriate for clinical decision analysis. Three direct methods are in general use to measure utility: rank and score, standard gamble and time trade-off. Indirect measures use pre-scored systems derived from direct measurement from the general public. Indirect measures include multiple health status attributes, such as physical activity, social activity, symptoms/conditions as well as self-rated health. QALYS and DALYS are examples of indirect measures.

Consider first the direct measures. The rank and score approach determines outcomes, ranks them from best to worst, determines a scale, anchors the scale end points, values outcomes on the scale and checks for rank and value consistency. For example, Figure 1 shows possible treatments and likely outcomes for carcinoma of larynx stage 3. Relative values are shown in Table 1.

Table 1 - Example of Rank and Score Outcome Values

Rank	Value	Outcome
1	100	25 year survival, normal anatomy, normal speech
2	70	25 year survival, tracheostomy, artificial speech
3	60	10 year survival, normal anatomy, normal speech
4	50	10 year survival, tracheostomy, artificial speech
5	0	Death

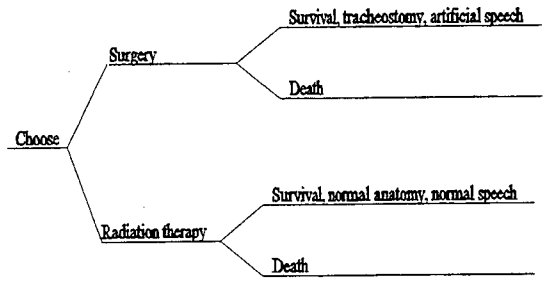


Figure 1

The standard gamble method considers two possibilities, a certain outcome intermediate between the best possible outcome and the worst possible outcome, or a gamble that the outcome could be either the best possible outcome or the worst possible outcome. The worst possible outcome is often seen as death. Figure 2 shows a schematic diagram of the standard gamble

method. The utility value is found by asking people to indicate the point where they are indifferent between the alternatives.

The time trade-off method allows comparison between alternative approaches. For example, one alternative would result in perfect health for some number of years, but a second alternative would result in the person living longer but at a lesser state of health.

There are several indirect utility measures that are used to measure quality-adjusted life years (QALYS). These include the Health Utilities Index (HUI), the Quality of Well Being Scale (QWB), the EuroQol and Years of Healthy Life (YHL). Utility values developed from these scales can then be used to measure quality of life. Consider a hypothetical case where without a prevention program a person might live an additional 30 years, but at a quality level of 0.7, whereas with a prevention program they might live an additional 75 years of a quality level of 1.0, that is, perfect health. This means that with the prevention program the individual would experience 75 life years, and without the program the individual would experience 30 x 0.7 = 21 life years. Thus, the prevention program would save 75 - 21 = 54 life years (undiscounted).

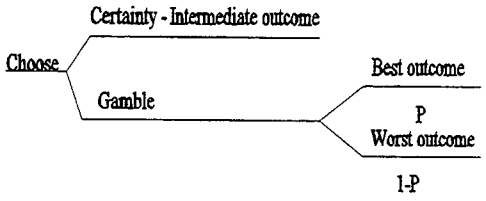


Figure 2

The Quality of Well Being Scale is calculated by adding the scale value for four categories of health status: mobility, physical activity, social activity and symptom/problem complex. The level definitions for these categories are shown in Tables 2 and 3.

Consider, for example, a person who is able to use routine transportation, but is wheelchair bound, does not require the assistance of others to get about, has no limitations in social activity but nevertheless has general tiredness and pain in their feet. In this case the QWB would be calculated as follows:

	Level	Preference
Mobility (MOB)	5	-.000
Physical Activity (PAC)	3	-0.060
Social Activity (SAC)	5	-0.00
Symptom Complex (CPX)		
Tiredness	10	-0.25
Pain	7	-0.299

QWB = 1 + MOB + PAC + SAC + CPX
= 1 - 0.000 - 0.060 - 0.000 - 0.299
= 0.641

Table 2 - Quality of Well Being Scale, Mobility, Physical Activity, Social Activity

Level	Mobility Scale
5	No limitations for health reasons
4	Did not drive a car, health related; did not ride in a car as usual for age (younger than 15), health related
3	Did not use public transportation, health related
2	Had or would have used more help than usual for age to use public transportation, health related
1	In hospital, health related
Level	Physical Activity Scale
4	No limitations for health reasons
3	In wheelchair, moved or controlled movement of wheel chair without help form someone else
2	Had trouble or did not try to lift, scoop, bend over, or use stairs or inclines, health related; limped, used a cane, crutches or walker, health related; had any other physical limitation in walking or did not try to walk as far or as fast as others the same age are able, health related
1	In wheelchair, did not move or control the movement of wheelchair without help from someone else, or in bed, chair or couch for most of the day, health related
Level	Social Activity Scale
5	No limitations for health reasons
4	Limited in other (e.g. recreational) role activity, health related
3	Limited in major (primary) role activity, health related
2	Performed no major role activity, health related, but did perform self-care activities
1	Performed no major role activity, health related, and did not perform or had more help than usual in performance of one or more self-care activities, health related

Table 3 - Quality of Well Being Scale, Symptom/Problem Complexes

Level	Symptom/Problem Complexes
21	Breathing smoke or unpleasant air
20	Wore eyeglasses or contact lenses
19	Taking medication or staying on a prescribed diet for health reasons
18	Pain in ear, tooth, jaw, throat, lips, tongue; several missing or crooked permanent teeth - including wearing bridges or false teeth; stuffy, runny nose; or any trouble hearing - including wearing a hearing aid
17	Overweight for age and height or skin defect of face, body, arms or legs, such as scars, pimples, warts, bruises or change in color
16	Pain or discomfort in one or both eyes (such as burning or itching) or any trouble seeing after correction
15	Trouble talking such as lisp. Stuttering, hoarseness or unable to speak
14	Burning or itching rash on large areas of face, body, arms or legs
13	Headache or dizziness or ring in ears or spells of feeling hot or nervous or shaky
12	Spells of feeling upset, being depressed or of crying
11	Cough, wheezing or shortness of breath, with or without fever, chills or aching all over
10	General tiredness, weakness or weight loss
9	Sick or upset stomach, vomiting or loose bowel movement, with or without fever, chills or aching all over
8	Pain, burning, bleeding, itching or other difficulty with rectum, bowel movements or urination (passing water)
7	Pain, stiffness, weakness, numbness or other discomfort in chest, stomach (including hernia or rupture), side, neck, back, hips or any joints or hands, feet, arms or legs
6	Any combination of one or more hands, feet, arms or legs either missing, deformed (crooked) paralyzed (unable to move), or broken - including wearing artificial limbs or braces
5	Trouble learning, remembering, or thinking clearly
4	Pain, bleeding, itching or discharge (drainage) from sexual organs - does not include normal menstrual bleeding
3	Burn over large areas of face, body, arms or legs
2	Loss of consciousness such as a seizure (fits), fainting or coma (out cold or knocked out)
1	Death

DALYS are essentially the same as QALYS with technical differences in determining the time preferences. DALYS preferences are assigned to reflect a broad consensus among those practicing international public health. As a result, DALYS are useful for determining global burdens of disease, whereas QALYS are preferred for determining prevention effectiveness.

Certain problems remain that require further development of preference weighted measures. Definitions of quality need to be more sensitive to well populations rather than those affected by disease or injury and quality adjustments are needed from the general population. An issue not fully resolved is the question of society's values as compared to individual values. There is also a need for life tables for specific populations and a need to work toward consistency in prevention effectiveness analysis.

Additional information on these issues can be found in the following references:

Gold MR, Siegel JE, Russell LB, Weinstein MC (eds). *Cost-Effectiveness in Health and Medicine.* New York: Oxford University Press 1996

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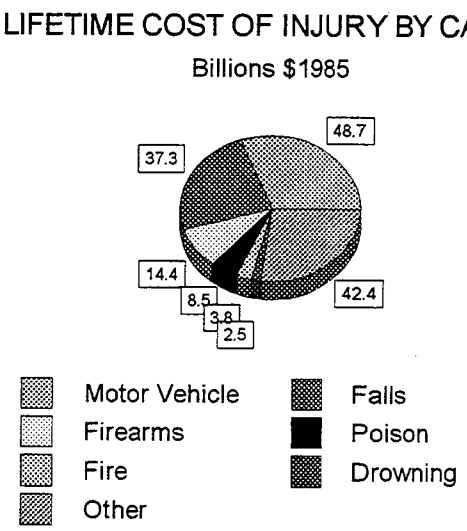
SOCIETAL COSTS

Wendy Max, Associate Professor of Medical Economics, University of California in San Francisco

The "cost of injury " measures the value of all of the resources used as a result of an injury. The costs associated with this resource use could include both direct and indirect costs. The direct costs include those expended for medical care, mental health care, criminal justice services, social services as well as research, prevention and education. Medical care costs include the costs of hospitalizations, physician services, medications, other professional services, medical equipment and home modification. Indirect costs include lost or reduced productivity, lives lost, informal (unpaid) care, quality of life and pain and suffering.



Estimates of the costs of injury result in very large numbers. As an example, the $158 billion (1985) lifetime cost of injury includes 31 percent of the total costs as a result of motor vehicle injuries, 24 percent the result of falls, 9 percent the result of firearm injuries, etc. Depending on the type of injury, the distribution of costs into direct, morbidity, and mortality costs may be very different. The following table shows the distribution for all injuries, motor vehicle injuries, falls, and firearm related injuries. Whereas for falls the morbidity and direct costs are large, firearm injuries are so often fatal that mortality costs predominate.

Type of Injury	Morbidity Costs	Mortality Costs	Direct Costs
All	41	30	29
Motor Vehicle	39	36	25
Falls	56	4	40
Firearms	10	84	6

CONCEPTUAL FRAMEWORKS

There are two basic approaches to measuring costs, based on prevalence and incidence. The prevalence based approach includes the costs related to all of the cases in a given period of time, typically a year, regardless of the time of onset. This approach yields the cost during a given time period such as an annual cost. The incidence based approach includes the costs associated

with all onset cases occurring in a given time period followed for as long as costs are incurred. This approach yields lifetime costs.

There are two approaches for estimating the value of life in monetary terms, human capital and willingness-to-pay.

The human capital approach is based on what a person would produce in their lifetime. This includes market earnings and an imputed value for household production. Household production is valued at what it would take to purchase household services in the market. The value of a person's life, then, is the sum of real and imputed earnings over their lifetime. These earnings must be discounted to put them in common terms, usually the current year. Considerable efforts have been expended to determine what discount rate to use, and although this question is still open, there appears to be a consensus developing around 3%.

The willingness to pay approach incorporates all aspects of living - health, leisure, pain and suffering, etc. Several methods to estimate this value have been used, including occupational risk differentials, surveys and expenditures for safety. These methods yield a wide range of values, from at least $800,000 to $6.9 million. There does not appear to be a consensus on the appropriate value.

There is still another way to estimate the value of a life - the life years lost. This is a measure that doesn't attempt to assign a dollar value to life or value people according to what they're paid. Rather, it calculates the expected years of life remaining.

VIEWPOINTS

The costs of injury can be perceived differently depending on whose perspective is taken. For patients and their families, the concern is out of pocket costs for treatment and social services, co-payments for their care, income loss, psychological costs and pain and suffering. Providers, on the other hand, are concerned with what it costs to provide care. Their concerns are likely to focus on labor, material and equipment costs. Insurers are concerned with what the coverage is. This is likely to be a subset of direct costs. Society as a whole is concerned with all costs, both direct and indirect.

When estimating costs it is important to keep in mind that costs, charges, expenditures and payments are different, and the relationship among them can vary with time. Charge data are often available, but charges exceed costs and often bear little resemblance to the amount actually paid or to the cost of providing the service.

Another consideration is the cost of care received as opposed to the cost of care needed. Advocacy groups typically cite very high costs, presumably based on the costs of care the person would receive in an ideal world. These unmet needs may be difficult to measure.

TYPES OF ECONOMIC ANALYSES

There are a number of types of economic analyses that use cost measures:

- Cost of illness studies measure only the costs. That is, they do not also measure either the benefits or the effectiveness. These studies are used to justify interventions, to justify agency budgets, and for comparative purposes.

• Cost-effectiveness analyses compare the cost of an intervention with the outcome. Outcome is measured in whatever units are appropriate, such as lives saved or pain-free days. Outcome is not measured in dollar terms. This approach can be used to compare interventions that yield the same outcome, and the most cost effective outcome can be determined. Cost-effectiveness analyses do not tell if ANY of the alternatives are worth pursuing.

• Cost-utility analysis is a special case of cost-effectiveness analysis, in which the outcome is measured as quality-adjusted life years (QALYs). The results of a cost-utility analysis are usually expressed as cost per QALY gained. QALYS can be determined from patient interviews or expert panels.

• Cost-benefit analysis compares the costs and outcomes associated with an intervention and measures both in dollar terms. The difference between net present benefits and net present costs is obtained to yield a net present value. If this is positive, then the intervention is worth undertaking. Cost-benefit analysis can be used to compare alternative types of programs, such as should society provide either prenatal care or renal dialysis?

GAPS IN THE AVAILABLE DATA

One of the difficulties in performing economic analysis of injury costs is the number of gaps in the available data:

• *Lack of expenditure data.* The National Medical Expenditure Survey (NMES) is more than 10 years old, and the Medical Expenditure Panel Survey (MEPS) data are not yet available. Most surveys collect information on services used, but not the cost of those services. Hence, estimation of costs involves applying a unit cost to services used, or in some cases using very highly aggregated totals such as found in the National Crime Victimization Study (NVCS), which includes the cost of all medical care related to an injury.

• *Lack of cause of injury data.* The International Classification of Disease External Cause codes (ICD E codes) is the most widely used indicator of the cause of the injury, such as motor vehicle, fall, poisoning etc. Unfortunately, ICD-E coding is often inaccurate or missing in available data bases. Also, certain types of injury can't be identified even using ICD-E codes, such as skiing injuries, certain childhood injuries or injuries resulting from lack of bicycle helmet use.

• *Data are lacking for children.* Few data sources include large numbers of children, but there are times when one is specifically interested in the cost of injury to children. In these cases we are often forced to assume the costs to children are the same as those for adults using similar services. However, this is unlikely to be true. Particularly important for childhood injuries are the longer term consequences, which aren't well understood.

OTHER ISSUES

There are other areas in which further work is indicated.

• *Lack of longitudinal data sets.* Few data sources allow one to track costs over time. Thus, we have to make assumptions about the long-term consequences of injury. This probably results in an underestimate of the costs of rehabilitation, attendant care, and other cost categories

that are only related to the longer term care issue. Two injuries for which long-term cost data do exist are spinal cord and traumatic brain injuries.

- *Who pays?* National level data on sources of payments for injury are inadequate.

CONCLUSION

Cost estimation is an art rather than a science. Considerable judgment is involved about what cost categories to include and how to do the estimation. However, cost estimation is an important tool in injury control policy.

FUNCTIONAL CAPACITY

Ellen MacKenzie, Director, Injury Center, The Johns Hopkins University

Functional capacity is the capacity to perform certain tasks necessary for everyday living. It is not a measure of actual performance. Conceptually, it is also independent of the physical and social environment. This presentation discusses development and early application of an approach to measure functional capacity, called the Functional Capacity Index (FCI). The Index consists of ten dimensions that define levels of functioning which in the aggregate are intended to represent everyday functioning of an adult human, a numerical value for each level of functioning based on the value judgments of a cross section of the population, and an algorithm for combining the individual values into a whole body score. In its present state of development, the index has been calibrated for the situation one year post injury.

DEVELOPMENT OF THE FCI

The development of the FCI comprised the following steps: define functional capacity dimensions and levels within dimensions, scale the relative importance of varying levels of function and assign level of function to AIS '90 injury descriptions.

The result of the definition phase was the selection of the following dimensions: Eating, Excretory Function, Sexual Function, Ambulation, Hand/Arm Movement, Bending/Lifting, Vision, Auditory Function, Speech and Neurobehavioral (cognitive) Function.

A number of scaling issues were taken into account; i.e. to choose between (1) a holistic versus a decomposed approach, (2) standard gamble or category scaling, (3) raters. When deriving the whole body scores it was necessary to consider which model to use, weighted additive, muliplicative or modified multiplicative. The actual scaling exercise consisted of assigning values from 0 to 100 to the levels of limitation with each dimension, assigning weights to each dimension that reflect their relative importance and combining level values and dimension weights into a single whole body score. The severity of the limitations are defined in terms of their impact on overall functioning in everyday living.

Levels of functioning were assigned by an expert panel to each injury description in the AIS '90 dictionary. A detailed description of the FCI and its development can be found in Journal of Trauma 41(5):779-808 (1996).

APPLICATION OF FCI

The initial application of the FCI was to determine if the levels of functioning assigned by the expert panel reflected what happened to real people. A questionnaire was developed and a cohort of patients was selected from 12 trauma centers in Pennsylvania. Eligible patients were contacted and interviewed by phone and a subset of the group received the SIP by mail. All of the people interviewed had injuries resulting from a motor vehicle crash, were between 18 and 59 years old and had a predicted FCI greater than 0. A 10 percent sample of admissions with a predicted FCI equal to 0 were also interviewed.

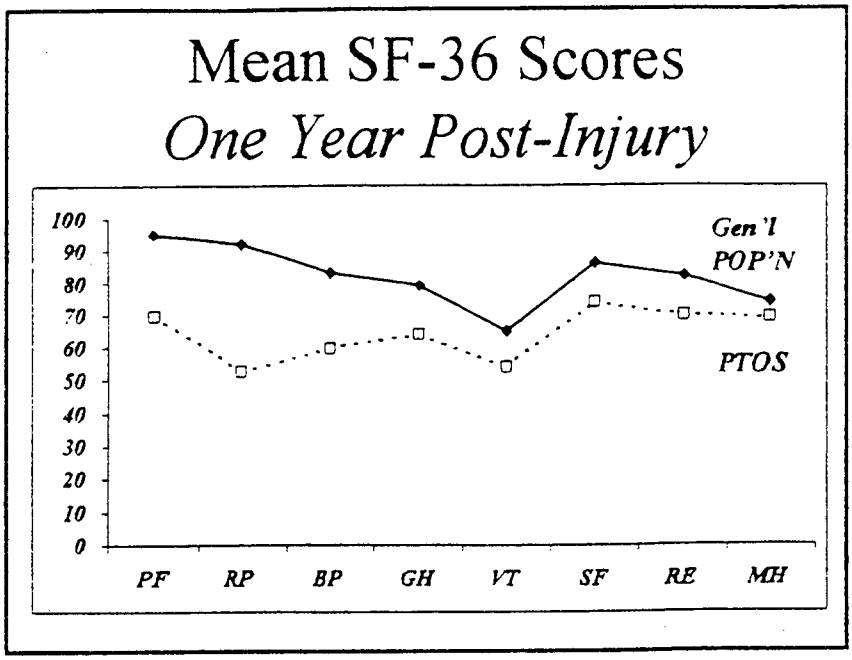
A total of 1540 people were contacted, 1238 were interviewed and 705 completed the SIP. Eighty two percent of the group were between age 18 and 44, 76 percent were male, 80 percent had a high school education and 76 percent had been working before their injury. During the interview, information was obtained on the socioeconomic status of the injured persons, and their pre-injury functioning. Questions were asked to ascertain their functional status based on the FCI. In addition, the SF-36 was administered and a subset received the SIP in the mail. The injury distribution by body region was as follows

Body Region	Head	Face	Abdomen	Thorax	Spine	Arm/ Hand	Leg
Percent	46	20	29	16	18	33	65

and the injury severity as measured by ISS was as follows:

ISS Range	1-8	9-15	16-24	25-34	35+
Percent	15	39	22	15	9

A comparison of the mean SF-36 scores with that of the general population of similar age and gender demonstrates that except in the area of mental health, trauma patients demonstrate significant decrements in function and well being.



PF = Physical Function
RP = Role Limitation due to Physical Problems
BP = Bodily Pain
GH = General Health
VT = Vitality
SF = Social function
RE = Role Limitation due to emotional problems
MH = Mental Health

VALIDATION

To fully validate the Index, it is necessary to consider content validity, concurrent validity and discriminant validity.

Content Validity

A total of 430 health states were used to describe the study subjects. Thirteen states described 50 percent of the subjects. This is considered good distribution. The number of attributes affected were as follows:

Number of Attributes Affected	0	1	2	3	4	5+
Percent	19	16	25	13	10	17

The percentage of the population affected with each attribute are as shown below:

Attribute	Eat	Excrete	Sex	Walk	Hand /Arm	Bend/ Lift	See	Hear	Speech	Cognitive
Percent	4	8	18	61	25	63	16	5	12	27

Clearly, most injuries resulted in limitations in walking and bending/lifting. It is important to point out, however, that 27 percent of the study participants reported a decrement in cognitive function.

Concurrent/Criterion Validity

To demonstrate concurrent validity, correlations were made with the SIP and SF-36, for both the overall FCI and dimension specific FCI scores. The correlation with the SIP shows good correlation with both the total score and the physical health score, and lesser correlation with the psychosocial health score:

Total Score	.65
Physical Health	.61
Psychosocial Health	.54

The correlation with the SF-36 shows good correlation with the physical health score and poor correlation with the mental health score, which is understandable as the FCI does not attempt to measure mental health.

Physical Health	.68
Mental Health	.40

As another measure of criterion validity, the FCI (together with the physical function components of the SF-36 and SIP) were correlated with self-assessed overall health status. The

table below displays mean scores by categories of self-assessed health. All 3 scales correlate well against this measure.

	SF-36	SIP	FCI
Excellent	50	7	23
Very Good	47	6	28
Good	41	11	42
Fair	34	17	59
Poor	28	23	78

Finally, the correlation of individual dimension-specific FCI with component scores of both the SF-36 and SIP were examined. The results for the SF-36 are summarized below. Given the content of the SF-36, the resulting pattern of correlations is not surprising.

Correlation of Individual FCI Dimension Scores with SF-36 scores

Attribute	Eat	Excrete	Sex	Walk	Hand /Arm	Bend/ Lift	See	Hear	Speech	Cognitive
Physical	.14	.32	.45	.78	.31	.72	.17	.09	.17	.30
Mental	.15	.14	.27	.22	.19	.26	.20	.08	.23	.46

Discriminant Validity

As a preliminary evaluation of the discriminant validity of the FCI, mean FCI scores were compared across seven subgroups of patients defined by their major injury. Across all 3 measures, persons whose major injury is to the abdomen or thorax have the best outcomes (highest scores on the SF-36 and lowest scores on the SIP and FCI). Persons with spinal cord injury have poor outcomes across all 3 scales. The SF-36 physical health scale, however, does not appear to reflect the consequences of major traumatic brain injury as does the FCI and SF-36

	SF-36	SIP	FCI
Abd/Thorax	49	4	21
Legs	44	15	36
Arms	45	6	35
SCI	40	16	52
Minor TBI	45	9	40
Major TBI	44	14	56
Multiple Major	41	12	40

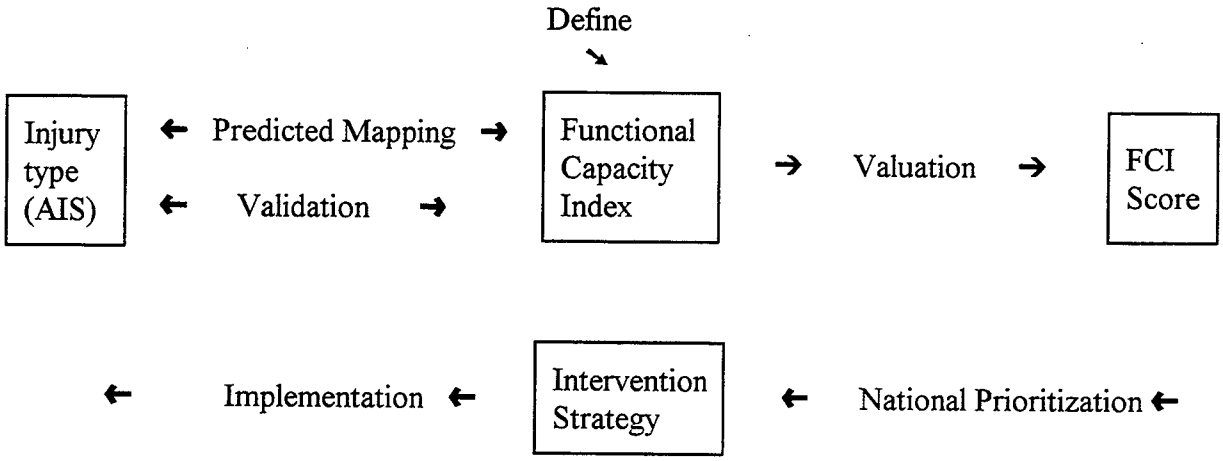
Although the results presented here are preliminary, they provide evidence to suggest that the FCI can be readily applied to measure physical function post-injury, correlates well (and in the expected directions) with established measures of health status and appears to discriminate reasonably well among persons with different types of injury. Although further testing and refinement of the FCI is warranted, it shows promise as a valid measure of functional capacity for trauma that is preference based and combines morbidity and mortality outcomes into a single metric.

PEDIATRIC FUNCTIONAL CAPACITY

Marc Hanfling, Director, Pediatric Injury Center, Baylor College of Medicine

Shown below is a model of the entire project with its inputs & outputs in squares, and phases as arrows as shown in the upper part. The bottom part reflects the possible implications of the FCI. My presentation today focuses on the first phase of this pediatric project, which is the Definition phase.

Development of the Functional Capacity Index



In light of the decrease in fatalities over the past ten years, the NHTSA has shifted more of its attention toward design and evaluation of counter measures that reduce the total long-term societal impact of injuries. There is an urgent need to develop more effective measures of societal consequences of nonfatal injuries. Typically this has been measured by their associated economic costs using the human capital approach. This approach underestimates the impact of injuries particularly on children. Luchter proposed measuring societal impact by multiplying a whole body impairment factor for the injuries sustained (such as the FCI presently proposed) by an individual by that person's remaining life expectancy. This results in an estimate of the number of years lived at reduced or impaired function. When applied to a population, the parameter becomes Life-years Lost of Injury (LLI).

MacKenzie and associates at Johns Hopkins responded to the initial request by NHTSA to further develop the tools proposed by Luchter and developed a multi-attribute index for non-elderly adults that maps anatomic description of the nature and extent of injury into scores that reflect the likely extent of functional limitations or reduced capacity.

All aspects of the development of the adult FCI did not take into account any consideration of differences in children. Therefore NHTSA developed a cooperative agreement with the Pediatric Injury Center at Baylor College of Medicine to develop a "derivative of the adult Functional Capacity Index" that would be applicable to children. This work is planned to be accomplished in four phases:

- Phase I - definition of the Functional Capacity Index.
- Phase II - mapping of the AIS injury descriptors to their likely/predicted Functional Capacity at one year post injury.
- Phase III - validation of the predicted mapping using actual patients from a trauma registry with known AIS injury descriptors and one year follow-up FCI determinations ascertained by phone survey.
- Phase IV - placement of a relative value from 0-100 for different levels of function within and between dimensions of function using responses from various groups representing society.

The first phase was completed by the core group comprised of researchers at Baylor College of Medicine and Harris County Hospital district reviewing the adult FCI and to determine its applicability to children, and if applicable to make it a seamless continuation of the adult FCI if possible. Ten functional dimensions were proposed for the adult model to define functional capacity 1 year post injury. These dimensions are cognition, eating, speech, excretory, bending/lifting, vision-best eye, arm/hand function-best hand, auditory-best ear, sexual, and ambulation.

In reviewing the adult FCI we advocated a developmental perspective in which the dimensions of the FCI are viewed as a process of change rather than as indicators of recovery to a stable baseline as in the previously healthy adult. We believed that the pediatric FCI should evaluate the impact of traumatic injury on development which may vary depending on the child's age/developmental stage and the dimension of the FCI. This developmental perspective is supported by the NIH Traumatic Coma Data Bank which showed age-related discontinuities in outcome of severe traumatic injury in children. Disability at one year post injury was greater in the 0-4 year group than the older child that sustained similar levels of acute injury severity.

The results of our review were that overall the adult FCI is applicable to children but there were certain caveats or changes that needed to be made:

- Sexual function: not applicable to children &/or not measurable & therefore it would be the single dimension that would reflect only future predicted function in adulthood rather than at the stated age in childhood. This dimension does not include reproduction capability, just intercourse.
- Cognition: Acquisition of new knowledge and skills is a major challenge for children as compared to adults whose major challenge is typically recovering to a preinjury baseline of performance of a previously acquired skill. Since learning/memory is an integral childhood function & not included in the adult FCI; and cognition is an indirect measure of learning capacity in children; we chose to keep cognition and add memory and learning as a specific subfunction of cognition.
- Bending & lifting: we added bending from a seated position to better delineate functional differences in children.
- Eating: we included both solids and liquids as well as differentiating 5 levels of function vs. only 3.
- Excretory: urinary and fecal retention was added to the description of excretory function.

- Psychological function: as in the adult FCI, psychological function was not included since it was not a physical function.
- Play was considered and was felt to be an important function but was felt to be incorporated in the ten dimensions and affected by psychosocial factors.

In an attempt to identify possible differences in injury outcomes and valuations, four physiologically and developmentally based age categories were incorporated into the model: 12-24 months, 25-60 months, 61-120 months and >120 months. This will allow the identification of potential differences in FCI scores for the same injury type for different ages.

Within each dimension the lower limit of applicability of each adult definition of function was determined. For example ambulation was considered applicable down to the greater than 24 months of age groups but not the 12 -23 month age group. In other words once a child reached 2 years of age their ambulatory functional capacity was roughly the equivalent of an adult.

After the core group developed the draft pediatric FCI, it was distributed to a national level consensus panel for further review, discussion and revision. Subsequent to that the Pedi FCI was published in the United States Federal Register for comments and a final document was established.

The current status of this project is as follows:

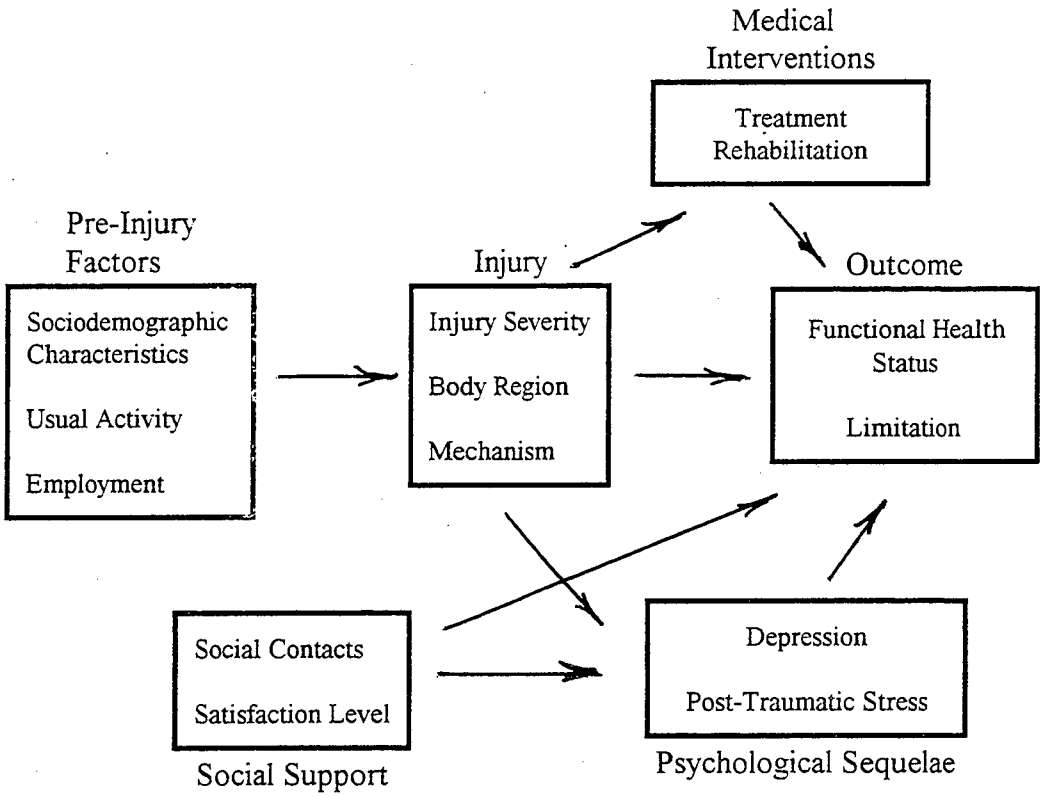
- Phase I, (definition), was completed and it was found that it is possible to revise the adult FCI with appropriate definitions and age categories.
- Phase II, (having experts map/predict 1 year functional capacity from AIS injury descriptions), is near completion.
- Phase III, (having different groups of society place relative value on the different Functional Capacities), is underway.
- Phase IV, (validating the mapping of the AIS anatomic descriptions to the FCI), will occur by telephone questionnaire and direct observation. Since little is known regarding the ability of parents to report by phone questionnaire their child's functional capacity, efforts are underway to validate the phone questionnaire by comparing it to the gold standard of in person exam or interview.

BEHAVIORAL EFFECTS

Troy Holbrook, Associate Professor of Family Medicine, University of California San Diego

Trauma outcome research is becoming increasingly important due to high survival rates. There is a wide variation in reported disability rates and predictors of outcome, which may be due the populations selected for the study, the followup intervals, small sample sizes or the sensitivity of survey instruments. In particular, little is known about the incidence of clinically significant depression after trauma and predictors of post-injury depression have not been identified. The Trauma Recovery Project (TRP) underway at the University of California in San Diego is a large prospective epidemiologic study which measures quality of life and psychologic sequelae resulting from traumatic injury at discharge and 6, 12 and 18 months after discharge. The objectives of this study are to report functional outcome using the Quality of Well-being scale (QWB), and to examine predictors of outcome after trauma. The conceptual model used in the study is shown in Figure 1.

Figure 1 - Conceptual Model Of Risk Factors For Functional Limitation



To be included in the study, individuals had to be 18 years old or older, been treated in one of the San Diego County Trauma Centers (UCSD, Sharp, Scripps, Mercy Hospitals), have been hospitalized for 24 hours or more, have an address in California or a bordering state, and

cord injury, a serious head injury (AIS 3+) or an address and phone number in Mexico. A total of 1,048 people were enrolled in the study. The sociodemographic characteristics of the enrollees in the project are as follows:

- Mean age 36 (±14.8) Range 18-91 Years
- 79% male
- Ethnic Group:
  - 52% White
  - 30% Hispanic
  - 18% Black/Other
- 40% Married or Living Together
- 41% Annual Income > $20,000
- 85% High School Education or Higher

The 6 month followup included 826 people (79 percent), the 12 month followup included 805 people (77 percent) and the 18 month followup included 780 people (74 percent). The variables measured are shown in Table 1, and the data gathered at injury and pre-discharge, and at the 6, 12, and 18 month followup are shown in Table 2.

Table 1 - Trauma Recovery Project Variables

Injury Characteristics (ISS, AIS)
Mechanism
Sociodemographic
Health Status Before Injury
Depression
Post-Traumatic Stress Disorder (PTSD)
Social Support

Table 2 - Trauma Recovery Project Injury and Pre-Discharge Instruments

Injury and Pre-Discharge	6, 12, and 18 month Followup
QWB	QWB
FDS	FDS
CES-D	CES-D
Social Support	Social Support
Sociodemographic	PTSD
Injury Data	Litigation
PTSS	

The psychologic assessment instrument used to measure depression was the Center for Epidemiologic Studies Depression Scale (CES-D). This scale ranges from 0 for no symptoms to a maximum of 48. A score of 16 or more is considered clinically significant depression. Traumatic stress disorder was measured by the Impact of Events scale, which has two subscales, IES-I Intrusive Thoughts, and IES-A Avoidance. Assessment of PTSD at the followup time points included the Diagnostic Interview Schedule (DSM=IIIR), with the diagnosis taken more than one month after the traumatic event.

The preliminary results show that at discharge, 60 percent of the enrollees were diagnosed

as having depression. At the 6 month followup this number had decreased to 26 percent. The predictors of depression at discharge and at 6 months are shown in Table 3. The values shown with one asterisk are significant at the 0.05 level, with two asterisks at the 0.01 level and with 3 asterisks at the 0.001 level.

Table 3 - TRP Depression Rates at Discharge and 6 Months

	ODDS RATIOS	
	Discharge	6 Months
Length of Stay (7+ days)	1.8**	1.9**
IES-A	4.6***	2.2***
IES-I	6.6***	2.5***
Life in Danger	2.1***	0.4*
Others Affected	1.6**	1.1
Control Over Event	1.4^	1.1
Gender	1.4*	2.4**
Marital Status	1.4*	1.4^
Education	1.6*	0.9
Income	2.2***	2.0***
Pedestrian Struck	2.6**	2.2*
Assault	1.1	1.7*

It also was found that depression at discharge predicts depression at 6 months

$$OR = 2.9\ (2.1\text{-}4.1)^{***}$$

At the 6 month followup, 32 percent of the enrollees were diagnosed with PTSD (30% male, 38% female), 9 percent had sought psychologic treatment (18 percent with PTSD sought treatment), 31 percent were a plaintiff in litigation (37 percent with PTSD). At the 12 month followup 17 percent of the enrollees had PTSD (12 percent male, 28 percent female), 7 percent had sought psychologic treatment (17% with PTSD sought treatment), 30 percent were a plaintiff in litigation (43 percent with PTSD). See Table 4.

Table 4 - Predictors of PTSD at 6 and 12 Months

	ODDS RATIOS	
	6 months	12 months
Gender	1.45^	3.36*
Ethnicity	1.10	1.10
IES-I	2.02*	2.35*
IES-A	1.59*	1.87*
Mechanism	2.22*	1.90*
# Social Supports	1.11	1.12

These results show that:

- Depression is common after major trauma, it is associated with the injury mechanism, sociodemographic factors, PTSD and with event parameters.
- PTSD is common at 6 months and is associated with gender (women), injury mechanism, and with IES-I and IES-A.

Based on these results, we conclude that psychosocial effects following traumatic injury are common, that depression is associated with poor outcome and the association between PTSD and outcome is not known.

CURRENT STATUS OF ICD-10 CM

Donnamaria Pickett, Medical Systems Administrator, National Center for Health Statistics

Since 1979, the U.S. has used the ICD-9 CM for morbidity applications. This is a clinical modification of the International Classification of Diseases Ninth revision (ICD-9), adapted from the World Health Organization. ICD-9 CM expands many of the concepts included in ICD-9 through extensive modifications including the use of fifth digit sub-classifications. The structure of clinical modification revisions permit statistics in ICD-9 CM to be collapsed back to ICD-9 for comparability between mortality and morbidity statistics. ICD-9 CM has been adopted by the federal government and the private sector for a number of purposes: statistical reporting, data collection, quality of care analyses, resource utilization, research, and reimbursement.

Since 1985, the ICD-9 CM has been updated on an annual basis to accommodate changes in medical technology and the need to provide greater specificity in classifying diagnoses and external causes of injury. Requests for modification are handled through the ICD-9 CM Coordination and Maintenance Committee. This Committee (co-chaired by the National Center for Health Statistics (NCHS), and the Health Care Finance Administration (HCFA)) was formed to provide a public forum to discuss possible updates and revisions to the ICD 9 CM. The Committee discusses such topics as the need to update the ICD-9 CM due to changes in medical technology, the need to provide greater specificity in classifying diagnoses (adding clinical detail and accuracy), as well as the need to correct inaccuracies in the classification. No official changes are made without being brought before this committee. While the ICD-9 CM has evolved considerably since 1979, it is now stretched beyond its intended purposes and is nearing the end of its capacity for responding to additional classification specificity, newly identified disease entities and other advances. There are few spaces left in ICD-9 CM for code expansion to enhance classification detail.

This is one of the reasons that the National Committee for Vital and Health Statistics (NCVHS), in 1993, recommended that the Department of Health and Human Services (DHHS) immediately commit resources to assess the applicability of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) for coding morbidity; to identify problem areas and make modifications, as necessary; and to develop implementation plans. The Subcommittee on Medical Classification Systems initiated a letter from NCVHS to the Assistant Secretary for Health and the Administrator of the Health Care Financing Administration recommending that the Department dedicate resources to determine the feasibility of implementing ICD-10 for morbidity application in the United States.

ICD, published by WHO, has greatly expanded since it was first implemented for mortality reporting. ICD-10, published in 1992 contains 2033 categories (855 more than ICD-9), with decimal subdivisions the total number of codes is 12,420. The original development of ICD-10 was an open process in which there was deliberate effort to involve all organized medical specialty groups. ICD-10 includes:

- significant improvements in coding primary care encounters, external causes of injury, mental disorders, neoplasms, preventive health
- new categories at the end of certain chapters for postprocedural disorders

- advances in medicine and medical technology that have occurred between the two revisions.
- codes to provide more detail on socioeconomic, family relationships, ambulatory care conditions, problems related to lifestyle and the results of screening tests.
- new histologic types.
- more space to accommodate expansions in the future

As of October 1996, WHO has authorized the publication of ICD-10 versions in 37 languages, with 28 countries having implemented ICD-10 for mortality and/or morbidity applications. The remainder of the countries are expected to implement ICD-10 by the Year 2000.

In September 1994 NCHS awarded a contract to the Center for Health Policy Studies (CHPS) to evaluate ICD-10 focusing on the suitability of ICD-10 as a statistical classification for morbidity reporting in the U.S., specifically emphasizing comparisons with ICD-9 CM. The initial purpose of this comprehensive evaluation was to:

- verify whether ICD-10 was a significant enough improvement over ICD-9-CM to warrant its implementation for morbidity reporting in the US
- develop recommendations to improve ICD-10 and to correct any problems identified during the course of the evaluation.
- develop a revised index and a crosswalk

The Technical Advisory Panel (TAP) convened under the contract consisted of 20 members representing a broad cross-section of the health care and coding community: federal members (HCFA, NCHS [Office of Analysis and Epidemiology and the Division of Vital Statistics], Agency for Health Care Policy and Research); classification experts; hospital representatives; and physician representatives. Considerable effort from a diverse group of knowledgeable classification experts was necessary to ensure that the results of the ICD-10 evaluation and the recommendations for clinical modification meet or exceed the high standards of previous revisions, adaptations, and modifications.

The TAP, in conducting the U.S. evaluation recognized the many advantages of the ICD-10 structure over ICD-9 CM, but also were cognizant of some deficiencies as a morbidity classification. These deficiencies included: the continued use of the dagger and asterisk convention (this convention was modified in ICD-9 CM by introducing combination codes for many conditions--the dagger/asterisk was never introduced in the U.S. with the implementation of ICD-9 CM); the need to return to the level of specificity implemented in ICD-9-CM; the need to facilitate Alphabetic Index use to assign codes; need to modify code titles and language to enhance consistency with accepted U.S. clinical practice; the need to remove codes unique to mortality coding, those designed specifically for the needs of emerging nations.

The TAP concluded that there were compelling reasons for recommending an "improved" (clinical modification) version of ICD-10 (ICD-10 CM) which would overcome most of the limitations. Therefore, the TAP strongly recommended that NCHS proceed with implementation of a revised version as soon as possible, stating:

> "ICD-10 CM represents a significant improvement in the clinical specificity, ease of use, and accessibility over both ICD-10 and ICD-9 CM. Hence, we make the strongest possible recommendation that the ICD-10 CM Tabular List and Alphabetic Index be adopted and implemented as the standard U.S. classification as soon as practical."

Following receipt of the final report, NCHS staff began further evaluation of the draft of ICD-10-CM developed under the contract. This second phase builds upon the completed evaluation study and the draft of ICD-10 CM. The focused reviews have concentrated on the following areas: (1) evaluation of residual categories ("Other") to determine whether further specificity is needed; (2) further evaluation of ICD-9 CM expansions that may not have achieved the desired effect or may require revision because of new data needs (e.g., insulin maintenance in non-insulin-dependent diabetes mellitus); (3) review of previous Coordination and Maintenance committee recommendations that could not be incorporated into ICD-9 CM due to space limitations; and (4) further evaluation of ICD-10 categories that may not have the desired specificity to provide information for ambulatory and managed care encounters, clinical decision-making and outcomes research. These areas are important to ensure the practical utility of a classification that is used for multiple morbidity applications.

During this second phase of modifications we have worked closely with speciality societies, to ensure clinical utility. We have held discussions and meetings and received comments from a number of medical clinical specialty groups and organizations. To date we have worked with the American Academy of Pediatrics, the American Academy of Neurology, the American College of Obstetricians and Gynecologists, the American Urological Association, the National Association of Children's Hospitals and Related Institutions, the American Burn Association, the Burn Foundation, the National Center for Injury Prevention and Control, the Office of Analysis and Epidemiology, the National Center for Infectious Diseases, the ANSI Z16.2 workgroup, the American Psychiatric Association, the American Academy of Dermatology, the Centers for Disease Control (CDC) Diabetes Program, and the Veterans Administration's National Diabetes Program, to discuss specific concerns or perceived unmet clinical needs encountered with ICD-10 CM. We have also had preliminary discussions with other users of the classification, specifically nursing, rehabilitation, primary care providers, National Committee for Quality Assurance (NCQA), and the long-term care, home health care and managed care organizations to solicit their comments about the classification.

The major modifications to ICD-10 CM include: combining of dagger/asterisk codes; the addition of a sixth character; incorporation of common 4th and 5th digit subclassifications (plan for full code titles); laterality; creation of combination diagnosis/symptoms codes; reassignment of certain categories to different chapters; deactivation of procedure codes; deactivation of "multiple" codes; and further expansion of post-operative complication codes. ICD-10-CM also remedies many cumbersome classification dilemmas, that have impaired ICD-9-CM, such as a major expansion in the chapter dealing with Factors Influencing Health Status and Contact with Health Services (Z codes) and the musculoskeletal chapter (M codes).

The draft of ICD-10 CM was placed on the NCHS homepage for a sixty-day public comment period which began mid-December, 1997 and ended February 27, 1998. The final version of ICD-10-CM will be completed upon thorough analysis of the comments received.

Educational materials, training programs and crosswalks between ICD-9 CM/ICD-10 CM will be finalized after changes have been made to the Tabular List and Alphabetic Index are completed. Also, NCHS plans to make available electronic formats as well as the traditional book formats.

No decision has been made regarding the implementation of ICD-10 CM. The designation of standards to be used for administrative and financial transactions now falls under the Administrative Simplification provisions of the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and includes standards for medical/surgical code sets. The proposed notice for standards to be used beginning Year 2000, published in a proposed notice of rule making (NPRM) on May 7, 1998 has recommended the use of existing standards, namely ICD-9 CM (for diagnosis and procedures), CPT-4, HCPCS, etc. Once Year 2000 standards are approved, any subsequent recommendations to move to a new standard must go through a new cycle of public hearings, publication of a Notice of Proposed Rulemaking (NPRM) and a final notice. Once the final notice has been published, the industry will have 24 months to prepare for the actual implementation date.

SOURCES OF PAYMENTS

Larry Blincoe, Chief, Regulatory Analysis Division, Office of Plans and Policy, NHTSA

NHTSA periodically conducts studies to estimate the cost of motor vehicle crashes. This was most recently done in 1996[2]. The results indicate that in 1994 these crashes cost $150.5 billion in medical care, lost productivity, property damage, and other crash related costs. About $17 billion of the total was for medical care. The 1996 report also included an examination of the issue of sources of payment. This presentation discusses how the sources of payments results in the 1996 report were developed as well as more recent work undertaken to further refine the earlier results.

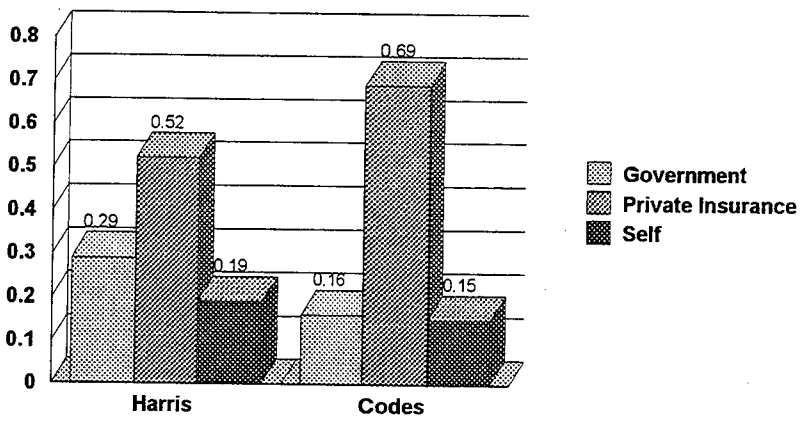
HOSPITAL DISCHARGES

In a 1992 study, Harris[3] used ICD-9 CM E-codes to isolate the sources of payments for the costs associated with motor vehicle injuries in 5 states based on hospital discharge records. Her study found that:

- Government paid 29%
- Private Insurance paid 52%
- Self (crash involved) paid 11%
- Charity/Unrecovered paid 8%

In 1995 the CODES program[4] reported sources of payments based on 1995 linked data from police reports, EMS, hospital and other injury records. For passenger vehicle drivers where safety belt use was known from the crash report, and for whom hospital admission was known:

- Government paid 16%
- Private Insurance paid 69 %
- Self/Others paid 1%



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[2] Blincoe LJ. The Economic Cost of Motor Vehicle Crashes 1994. DOT HS 808 425 July 1996

[3] Harris JS. Source of Payment for the Medical Cost of Motor Vehicle Injuries in the United States. DOT HS 807 800. January 1992

[4] National Highway Traffic Safety Administration, Benefits of Safety Belts and Motorcycle Helmets, Report to Congress February 1996

The conflicting results of these two reports were a cause for concern. It was unclear whether the conflicting results were due to different states in samples, or whether different coverage (drivers in CODES, all occupants in Harris) produced different results, possibly due to added liability of drivers as controlling parties. However, a careful examination of the data showed that states that were included in both studies had similar results (MO & NY), and that data from the one state that provided both driver and occupant data (NY) indicated no significant difference between drivers and passengers. From this it was concluded that the primary reason for the different results in the two reports was real differences in the payment experience of the two samples of states.

Data from both reports were combined to produce an approximation of payment experience across the U.S. To develop this national estimate it was necessary to weight the 12 state's data. Two possible weighting schemes were rejected:

- Population weights would skew results to California and NY disproportionately due to their true population weights.
- Simple Average would not reflect relative population at all.

Instead, the 12 state's data were weighted based on insurance characteristics, using the frequency of police reported injuries in 1993. States were grouped into those with and without no-fault insurance. The reasoning for the fault/no-fault choice was:

- In states with compulsory first party no-fault auto insurance, auto insurance is automatically considered the primary payor for motor vehicle crash injuries.
- Data indicate a strong correlation between no-fault laws and low public (or high private) payments for motor vehicle injuries.

Based on this weighting scheme the following results were found for inpatient charges for motor vehicle injuries:

Government - 23.4% (Federal - 13.9%, State - 9.5%)
Private Insurance - 58.0%
Self - 13.2%
Other - 5.4%

EMERGENCY DEPARTMENT

The distribution of emergency room charges was derived from a 1995 NHTSA report[5] based on 1992 NCHS emergency department survey data. A total of 1649 emergency room visits as a result of a motor vehicle injury were included in these data. This sources show the distribution of charges for emergency room visits resulting for motor vehicle injuries as follows:

Government - 14.7%
Private Insurance - 45.3%
Self - 26.8%
Other - 13.2%

[5] National Highway Traffic Safety Administration. Low-Threat-to-Life Motor Vehicle Injuries, A Profile of Motor Vehicle Injuries in Emergency Departments. DOT HS 808 329 September 1995

REHABILITATION

The cost distribution for long term rehabilitation care was derived from data supplied by the Rehabilitation Institute of Chicago (RIC). These data included 322 cases where motor vehicle injury was the cause of the injury. The distribution of these charges were found to be as follows:

Government - 49.6%
Private Insurance - 50.2%
Self - 0.2%

COMBINED MEDICAL COSTS

The charges for these three treatment categories were combined, weighting their distributions according to the estimated relative expenditures in each treatment category. Data sources used for the weighting procedure were as follows:

Costs:

Inpatient - CODES and Harris
ER - CODES (Utah only)
Rehab. - RIC

Incidence:

Inpatient - 1982-86 NASS
ER - 1982-86 NASS
Rehab. - Utah (0.6% of hospitalized are admitted to rehab).

The resulting weighted distribution was as follows:

Government - 24.2%
Private Insurance - 54.8%
Self - 14.6%
Other - 6.4%

CAVEATS

- Data in this study are from early-mid 1990s. The health care industry has been rapidly moving to managed care, which may impact the proportion of costs borne by different sources.
- Data are based on primary payor only. In reality, subrogation will distribute costs to secondary payors as well.
- Data were not available for physician visits. This analysis assumes that the payment profile for physician visits is similar to all hospitalized cases.
- Data for long-term rehabilitation are skimpy.
- Data are based on charges, which are becoming increasingly meaningless with the growth of managed care.

OTHER COSTS

Payments for "other" cost categories were estimated based on data from 1991 Urban Institute study "The Cost of Highway Crashes," with minor modifications. Government revenues

pay significant portion of costs for Medical care (24.2%), emergency services (79.6%), vocational rehabilitation (24.2 %), and market productivity (19.3%). Government sources do not pay significant portions of lost household productivity, workplace costs, legal and court costs, travel delay, or property damage. Overall, for all crash cost categories, the distribution of payments is as follows:

Government - 9.2%
Private Insurance - 54.6%
Self - 29.4%
Other - 6.8%

DISCUSSION

It is somewhat illusory to disaggregate costs across payment categories because ultimately it's individuals who pay either directly or through insurance premiums, taxes, or higher medical care costs (for unrecovered treatment costs). However, a real distinction can be made between costs born directly by those involved in the crash and those that impact society at large. The general public subsidizes most crash costs:

- costs paid from federal and state revenue are funded by taxes.
- costs borne by private insurance companies are paid by policyholders.
- unpaid medical charges are absorbed by health care providers and ultimately passed on as higher costs.

Society at large picks up over 70 percent of all crash costs incurred by individuals involved in crashes. Less than 30 percent is paid by those actually involved in crashes.

CURRENT RESEARCH

These problems have recently become more than just an academic interest to NHTSA. The recently passed transportation bill, TEA 21, contains a safety belt incentive grant program based on improvements in states safety belt use. About $1/2 billion is to be distributed to states over 6 years based on savings to the federal government from reduced Medicare and Medicaid expenditures resulting from injury reduction from safety belt use. Research is underway to refine the agency's estimates of federal expenditures and to address the concerns previously cited.

To check for shifts in payor distributions caused by shift in health care systems to managed care, data were obtained from the HCIA, an organization that collects data for the health care industry. The HCIA Projected Inpatient Database is a sample of 14.3 million discharges from 2308 U.S. short-term, general, nonfederal hospitals. Based on E-codes, about 250,000 motor vehicle crash cases were identified. The results are as follows:

	HCIA	NHTSA 1994
Government	22%	25%
Private Insurance	53%	58%
Self	14%	12%
Other	11%	5%

The HCIA "Other" category includes some "Unknown" cases which should probably be spread

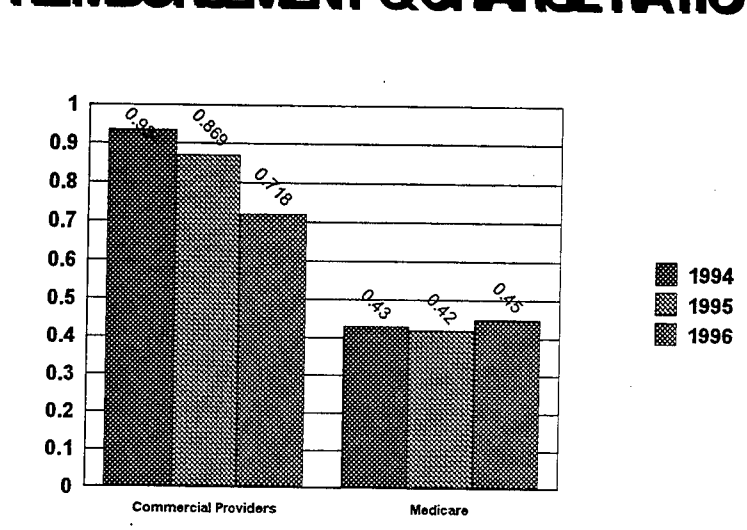
among other known payors. Therefore, there is probably no significant difference from the NHTSA 1996 estimate.

To adjust for distortion caused by use of Charges rather than Reimbursements data were obtained from the HCIA Continuum of Care Data Repository (CHAMP), a record of over 4 million enrollees in health plans of 70 large self-insured organizations. This data source includes 21 million outpatient encounters, 440,000 outpatient surgeries, and 370,000 hospital confinements.) Reimbursement/Charge ratios were calculated for a sample of commercial providers with the following results:

1994 - .934
1995 - .869
1996 - .718

Data were also obtained through HCIA from the Medicare Provider Analysis and Review (MEDPAR) database, which contains records for 100% of Medicare beneficiaries who use hospital inpatient services. These data were used to calculate Reimbursement/Charge ratios with the following results:

1994 - .43
1995 - .42
1996 - .45



Conclusion: Reimbursements are decreasing relative to charges in private insurance plans, but not under Medicare. However, because this ratio is smaller for Medicare, analyses based on charges will probably overstate the government revenue share of total costs, and understate the private or self share. Research is needed to determine source of payments based on reimbursements for Medicaid, which generally represents a larger share of government expenditures than Medicare.

DATA LINKAGE

Pat Nechodom, Director, CODES Project, University of Utah

In 1992, the National Highway Traffic Safety Administration (NHTSA) funded seven states to link medical data with police crash reports. This project is called the Crash Outcome Data Evaluation System (CODES). The funded states are: Hawaii, Maine, Missouri, New York, Pennsylvania, Utah, and Wisconsin. All states used Matchware's Automatch software to perform probabilistic data linkage. With probabilistic linkage technology, a clear picture of the medical and financial outcome of motor vehicle crashes can be evaluated. In 1997, an additional seven states were funded, bringing statewide linkage technology to Connecticut, Maryland, Nevada, New Hampshire, North Dakota, Oklahoma, and South Dakota. Alaska and New Mexico were funded for demonstration projects for specific targeted issues. All states were required to produce a statewide linkage of the police crash reports to medical records although states accomplished this end in various manners dependent upon the availability of various databases.

The University of Utah CODES project linked the Utah 1991 statewide police crash reports to the statewide Emergency Medical Services (EMS) database and further linked the police data to the hospital outpatient, inpatient and rehabilitation discharge records. The Driving Under the Influence (DUI) conviction files were linked as well. The Vehicle Identification Number (VIN) codes on all involved vehicles were decoded for the purpose of identifying vehicle specific information. With the linked database, the Utah CODES project was able to follow each crash victim through the medical system. Since the study was population based, uninjured crash victims were studied as well as the injured victims. The CODES projects were able to better understand some of the reasons why some victims are injured and others are not.

Some of the elements necessary for probabilistic data linkage are:

Probabilistic linkage software
Computerized crash and injury data
Discriminatory identifiers in all databases.

The final 1991 Utah linked database includes data from 43 Utah hospital. Since there was no centrally collected hospital database, Utah CODES personnel contacted all hospitals, entered into a confidentiality agreement with each hospital to assure that no victim-level data would be released and standardized all of the various formats to develop one database. EMS records were not 100% electronically collected, nor were they in all the same format. Data entry personnel were hired and an EMS database was developed. After linking the crash records with the medical records, all personal identifiers were removed. A sanitized, public-release database was prepared. Remaining was a database that containing 98,373 crash occupants with a potential of 239 variables for each individual. With this linked database, researchers could study a crash victim from the crash through the medical system. All information is released on an aggregate level, protecting the privacy of crash victims.

A picture of the crash at an individual level can be developed using the variables from all of the databases. For example, the following hypothetical scenario could be developed:

A crash victim in a passenger vehicle (equipped with ABS and a three-point restraint system, etc.) fell asleep on a rural road, rolling the vehicle. The victim was not wearing a seat belt, was

injured by the steering wheel and had bruises and abrasions. EMS was dispatched and arrived at the scene in 8 minutes. EMS personnel treated the victim at the scene, applying a splint and oxygen. After 14 minutes the victim was transported by EMS to the hospital Emergency Department, with a transport time of 4 minutes. At the hospital, the crash victim was evaluated and admitted to the hospital as an inpatient. Hospital discharge records list up to 10 ICD-9 CM codes that further describe the victims medical status. Additionally, hospital charges are collected and the final discharge status is noted (was the crash victim discharged home, to a nursing care facility, rehabilitation, etc.?).

Since the Utah 1991 linkage was accomplished, the Utah State Legislature has mandated the collection of statewide hospital Emergency Department and hospital inpatient discharge data. Starting in 1996, the Utah CODES project has been able to perform linkage on centrally collected EMS, Emergency Department and hospital inpatient discharge data. All data required for linkage is contractually acquired from the Utah Department of Health. Linked data has been used to help with legislative issues, for problem identification and program evaluation at the health district level, for research, and for informational purposes.

Many of the CODES states have supported their state legislators with analysis of the following issues: primary seat belt law; motorcycle helmet mandates; allocation of the tourist tax; DUI programs; and graduated licensing for youthful drivers. Data linkage attaches medical charges to traffic safety issues. In many cases, state legislators must evaluate programs from an economical standpoint. The linked data can help legislators understand the financial outcome of legislation. State and local health districts have used the linked data to help with problem identification and program evaluation. It is important that local data be used to solve local problems, and the state specific linked data can help agencies target their particular areas of concern. Most CODES states have been authorized by the data providers to release data at a county level. The linked CODES data allows states and counties to understand the economic magnitude of a problem in the locale.

Research projects among the CODES states has been varied: traumatic brain injury in the motorcycle crash victim; liver and spleen lacerations in restrained and unrestrained crash victims; geographical mapping of specific crash types; medical and financial impact of drivers with identified medical conditions; and DUI prosecution of injured drivers. CODES data has also been used for the purpose of disseminating information to the public through newspapers, television and the publishing of the Public Safety Crash Summary.

When the original CODES states had completed their individual projects, some findings were universal: seat belts prevent injury, hospital charges are less for restrained crash victims than for unrestrained victims, and approximately 10% of all crash victims require an EMS run. However, the importance of localization of data linkage was evident:

- In Maine, you are 10.7 times more likely to be injured if you hit a moose than if you hit a deer.
- In Connecticut, hitting a tree is the #1 fixed object hit that results in death; In

Hawaii, hitting a palm tree doesn't have quite the same results.

- In South Dakota, legal drivers age 14-15 account for 4.5% of all crashes
- Pennsylvania discovered some interesting information about their motor vehicle crashes:
    - average hospital charges for Medicaid patients were about 50% higher than for all other patients
    - males between the ages 16 and 40 incurred the greatest hospital charges
    - males were 4 times more likely to be cited for DUI while 75% of those drivers under the influence chose not wear a safety belt
- The New Hampshire CODES project assisted the Concord, New Hampshire police in the evaluation of a specific stretch of highway. They took a three-point approach to the problem, looking at crash characteristics, engineering design, and medical impact of crashes on the community. The New Hampshire project quantitatively described 1995 motor vehicle crashes that occurred on Louden Road by frequency distribution for time of day, location, causative and contributing factors. They further identified patterns that might provide insight into potential roadway design modifications or traffic flow control. Linked data was used to assess the medical and financial impact of injuries sustained as the result of 1995 Louden Road crashes.

In 1997, the Utah State Legislature considered a graduated drivers license bill that would mandate a restructuring of the driver licensing system for all drivers under the age of 18. A tiered system was introduced that would allow youthful drivers more practice driving time behind the wheel with an experienced driver. Additionally, all youthful drivers would have to wear safety restraints (as well as all passengers in the vehicle) and would not progress through the system if they were responsible for a motor vehicle crash or were convicted of a moving traffic violation during the initial licensing steps. Linked data were used to evaluate the medical and financial outcome of the graduated licensing bill.

Linked data revealed that 16 - 19 year old drivers were 3.5 times more likely to be involved in a serious or fatal crash if no person age 21 or over was in the vehicle. Additionally, 16 - 19 years old drivers were 4 times more likely to be the driver that was deemed by the police to be the cause of the crash when no person age 21 or over was in the vehicle.

Graphing of the data showing the time of day of the crash revealed that the frequency of crashes for 16 year old drivers was greatest during the hours of 7 AM and 8 AM and between 2 PM and 4 PM, presumably when the youthful drivers are driving to and from school. The plotting of crash frequencies for 16-year-old drivers for the summer months did not reveal a like pattern. Analysis of the linked data showed that $1,959,596 in hospital charges could have been saved in Utah in 1991 if a 16 year old had not driven to school. Additionally, passengers in a vehicle with a 16 year old driver who crashes are 2.7 times more likely to end up as a hospital inpatient than the driver of the vehicle, and 1.5 times more likely to require an emergency department visit than the driver of the vehicle. Measuring the impact that mandating 16-year-olds be restrained revealed that in 1991, $445,112 in Utah hospital charges could have been saved if the unbelted 16-year-olds had been belted.

The 1997 bill didn't make it through the house. "*Lawmakers felt it was an intrusion on*

parental responsibilities." Salt Lake Tribune, 2/12/97. Approximately 2 weeks later, on February 28, 1997, two Utah teenagers died in a motor vehicle crash. The scenario was all too predictable. The 16-year-old driver had had her driver's license for 3 days and drove to school. Four students age 15 and 16 were in the vehicle. According to the police crash report, the driver of the vehicle had misjudged the distance of an oncoming 18-wheeler and attempted a left-hand turn in front of the truck. The truck struck the passenger side of the vehicle, killing two of the passengers. A third passenger was hospitalized for two weeks, while the 16-year-old driver was hospitalized for two days. No one in the vehicle was wearing a seat belt. On 4/20/98, an editorial in the Salt Lake Tribune stated, "It makes sense to require young drivers to log more practice miles before turning them loose. The legislature should make it so."

Linking data sets can help accomplish an end that cannot be attained by analyzing individual data sets. Crash, driver and vehicle characteristics can be evaluated in terms of health care outcomes for a real medical and financial overview of traffic safety issues.

MEASURING THE BURDEN OF INJURY CONFERENCE

Marc Hanfling, Director, Pediatric Injury Center, Baylor College of Medicine

An international conference on "Measuring the Burden of Injury" was held in Noordwijkerhout, Netherlands on May 13-15, 1998. This was a satellite conference of the Fourth World Injury Conference held in Amsterdam the following week. The European Consumer Safety Association (ECOSA) was the principal sponsor of the conference. There were 70 participants from 18 countries.

The conference was organized into 4 major sessions, plus a workshop and assorted free papers. The topics of the major sessions were Economic Costs, Measuring Health Status and Quality of Well-being, Valuation of Life and Non-fatal injuries, and Cost-benefit and Cost-effectiveness analysis. A copy of the conference agenda is shown in Table 1.

The bulk of the presentations dealt with economic or cost issues. It is interesting to note that none of the papers presented in the economics session gave any indication of their uncertainty or range of costs with differing assumptions. There was considerable discussion on why economic results are not presented along with their uncertainties, and it was generally agreed that this was possible and should probably be done.

Highlights of the presentations are as follows.

Dr. Shanti Ameratunga from New Zealand presented a proposal for a very interesting and ambitious prospective case controlled evaluation of the long term burden of disability attributable to motor vehicle crash injuries. The methods would address many of the concerns and confounders brought up in the conference. Premorbid information would be gathered at hospitalization including health status, alcohol usage, social network and support. At 3 and 12 months post injury the Medical Outcomes Study Short Form 36 (SF 36) or Child Health Questionnaire (CHQ) would be administered.

Dr. G. Guraj from India presented an interesting study of quality of life outcome in a developing country. He reported on disabilities, socio-economic burden and quality of life among 105 traumatic brain injured survivors. Assessments at discharge and at 6 months, including disability (measured on a severe, moderate, mild and nil scale), economic costs in terms of expenditure, work loss and income deprivation, were determined by interview and hospital costs were determined from medical records. Disability was found as shown. The economic costs results show that the government paid 72 percent, with the remaining 28 percent self pay. Other economic results showed that 63 percent of the patients needed additional loans for treatment and rehabilitation, that 60 percent could not work at 6 months, and 75 percent were struggling with financing their rehabilitation.

Percent of Patients with Disability		
Level	Discharge	6 months
Severe	53	15
Moderate	34	14
Mild	11	69
Nil	2	2

A general model for looking at costs was outlined by Ted Miller. He noted that comprehensive costs include both economic and quality of life costs. He also focused the

discussion on some issues not often considered. There was discussion regarding the utility of measuring medical costs by calculating from the bottom up, that is looking at costs per patient

COMPREHENSIVE COSTS				
ECONOMIC COSTS				QUALITY OF LIFE
Medical	Work/ Production	Government	Incident	Quality of life
Top down vs Bottom up	Motorist Delay	Prevention	Reputation	
	Short Term vs Long Term	Research		

suffering a particular mechanism or type of injury at the hospital or medical provider. This is most accurate but most difficult and costly to measure versus calculating cost from the top down using government or insurance figures. Under work or production costs, for motor vehicle collisions, the traffic delays result in increased travel time and possible decreased production for affected motorists.

As part of the discussion of production costs, there was a debate over what should be included in the loss of work productivity costs when calculating QALYS (Quality Adjusted Life Years Saved) i. e. for a person that dies or has a long term disability and can not work. One school of thought, the Human Capital approach, supported by Miller, argued that the purpose of life is to produce and to produce over a lifetime. Therefore one estimates a person's production potential by calculating a person's life time earning potential. An alternative theory, proposed by Ben van Hout of Erasmus University of Netherlands is the Friction Cost approach or "actual/real cost" to the employer and society to replace the dead or disabled person. The argument is that just because you are no longer working doesn't mean society lost your productivity/salary for life. The employer and society adapt and move on at varying costs and length of times depending upon the type of work (how difficult is it to replace your skills) and the economic setting (i. e. degree of unemployment). They propose that the cost to society is a limited amount over a limited time.

Under government costs, besides the usual costs of police, social workers, etc., one often forgets the costs associated with prevention and research. In addition to the usual incident costs of property damage etc., one needs to consider costs of loss of reputation i. e. an airlines loss of reputation and possible lost revenues subsequent to a crash.

Another viewpoint on economic costs was presented by David Ball from the UK. He said that economists are forever struggling with different models to answer the question of how much to spend on safety or any other intervention, using prioritization schemes based on the monetary valuation of life and non-fatal injuries. Multiple techniques have been tried and all have significant methodological shortcomings and a high degree of uncertainty, up to 10 fold. But, we can and must live with this by presenting the alternative approaches with their limitations and uncertainty. There was discussion that politicians may want a narrow focused answer to complex questions.

A report on an approach toward consensus being taken in Europe was given by Saakje Mulder of the Consumer Safety Institute in the Netherlands. She reported on the efforts of the European Consumer Safety Association (ECOSA). This group is working towards consensus building by minimizing variations in the various nation's cost of injury figures that result from different conceptual and methodological approaches. When that goal is achieved the results will reflect real differences in national health care services, population demographics and strength of the economy. The ECOSA Working Group was established in 1995 with eleven participants from 8 countries. The membership is multidisciplinary, including health economists, epidemiologists and physicians. Products to date include a glossary of 200 terms based on WHO and ICD E codes, a review of the current literature that includes a bibliography of 400 references, and consensus on patient groupings and cost elements for a model to calculate direct costs of home and leisure injuries. Most of the information can be found on the ECOSA website.

An interesting presentation by Rune Elvik from Norway considered the implications of the Swedish effort to obtain zero fatalities from motor vehicle crashes. The conclusion was that it was likely that the overall mortality level would increase as a disproportionate amount of the national resources were given to reducing motor vehicle fatalities.

A presentation on public health costs of sports injuries by Caroline Finch of Australia focused on the costs that were in addition to the obvious economic costs, including the physical, psychological and emotional damage that might result from the healthy life style aspects of participation in sports and for professional athletes the threat to their careers.

Another sports injury related presentation by Vincent Hildebrandt of the Netherlands covered the balance of costs and benefits of sport activity on health, including the avoidance of the need for medical services and the use of paid sick leave. The study was based on a cross sectional sample of 5,000 in the 1991 Dutch Health Survey. The results showed that even though there was a large cost resulting from injuries, the cost savings of avoided disorders such as cardiovascular diseases and osteoporosis, benefits occur in the older population but not the younger.

The costs and benefits of traffic accident countermeasures was discussed by Frank Poppe of the Netherlands. His results showed that direct and indirect costs of motor vehicle crashes was 2 percent of gross domestic product (GDP). He also discussed the Dutch approach to a sustainable road traffic system as focusing on human possibilities as a starting point, making large differences in speed and mass impossible, and providing a small number of clearly recognized types of roads. He reported that the Dutch have spent 60 billion guilders over the past 20 years and have achieved a positive cost benefit as a result of an 80 percent decrease in motor vehicle crashes.

The application of DALYS to the Dutch situation was presented by Pieter Kramers of the Netherlands. Their approach was to compare injury morbidity to other causes of medical morbidity, such as cancer, mental illness, etc. Fifty two diseases and disorders were analyzed. Injuries were found to account for 5 percent of the total DALYS, compared to cardiovascular diseases more than 20 percent. The authors believed the injury estimate was an underestimate due to inadequate injury related disability information.

Table 1 - Agenda, Conference on Measuring the Burden of Injury
Noordwijkerhout, The Netherlands, May 13-15, 1998

Introduction: Ed van Beeck, Erasmus University, Rotterdam, the Netherlands
Welcome: Steven van Hoogstraten, Ministry of Health, Welfare and Sport, Director of Public Health
Keynote: The ethics of cost benefit analyses, Wim Rogmans, General Secretary of ECOSA

Session 1: Economic costs, Ted Miller, National Public Services Research Institute, Landover, USA, Chair
Socio-economic costs of injuries and fatalities resulting from the practice of sports and recreational activities in Quebec, Claude Goulet, Research Agent of Quebec Sports Safety, Trois-Rivieres, Canada.
Development of a road injury cost database, Delia Hendrie, University of Western Australia, Perth, Australia
What are the costs of accidents at work?, Johanna Kuusela, VTT Manufacturing Technology, Tampere, Finland

Session 2: Measuring Health Status and Quality of Well-Being, Ellen MacKenzie. Johns Hopkins University, Baltimore, USA, Chair
Measuring the burden of disability attributable to car crashes: a follow-up study of participants in a case-control study, Shanti Ameratunga, University of Auckland, Auckland, New Zealand
Disabilities, socio-economic burden and quality of live among traumatic brain injury survivors, G. Gururay, National Institute of Mental Health & Neuro Sciences, Bangalore, India
Development of an index to quantify the functional outcome of pediatric motor vehicle injuries: Phase I, to define a pediatric derivative of the adult functional capacity index, Marcus Hanfling, Baylor College of Medicine, Houston, USA

Session 3: Valuation of Life and Non-fatal injuries, David Ball, Middlesex University, United Kingdom, Chair
Can injury prevention efforts go too far? Reflections on some possible implications of the zero fatalities vision for traffic injury launched by the Swedish National Road Administration, Rune Elvik, Institute of Transport Economics, Etterstad, Norway
Estimation of the direct costs of severe injuries in road accidents in Denmark, Christian K. Andersen, Odense University, Odense, Denmark
The cost of injury in Victoria, Australia, Wendy Watson, Monash University, Clayton Victoria, Australia

Free paper presentations
Medical care to injuries, results of a survey in the Netherlands, Marieke Schellart, Consumer Safety Institute, Amsterdam, the Netherlands
Epidemiology of head injuries with hospital admission in Portugal: Reflections on inpatient of national health service hospitals from 1993 to 1996, José António André Giria, Ministry of Health, Lisbon, Portugal
The public health costs of sports injuries, Caroline Finch, Deakin University, Burwood Victoria, Australia
The activities of the ECOSA working group. Saakje Mulder, Consumer Safety Institute, Amsterdam, the Netherlands

The evaluation of indirect costs of road traffic accidents in Italy, Alessio Pitidis, Ministerio della Sanità, Rome, Italy

Session 4: Cost-benefit and Cost-effectiveness Analysis, Ben van Hout, Institute for Medical Technology Assessment, Rotterdam, the Netherlands, Chair

Benefits and costs of the health effects of sports, Vincent Hildebrandt, NIA TNO, Amsterdam, the Netherlands

Traffic accidents: Their cost and the benefits of countermeasures, a macro approach, Frank Poppe, SWOV Institute for Road Safety and Research, Leidschendam, the Netherlands

Workshops

Workshop on Economic costs, Suzanne Tylko, Biokinetics and Associates, Ottawa, Canada, Facilitator

Workshop on Health Status Measurement, Stephen Luchter, National Highway Traffic Safety, Washington, USA, Facilitator

Workshop on Valuation of Life and Non Fatal Injuries, Kristal Kidholm, Odense University, Odense, Denmark, Facilitator

Workshop on Cost-benefit and Cost-effectiveness analysis, Branko Kopjar, National Institute of Public Health, Oslo, Norway, Facilitator

Composite public health measures: DALY's, Louise Gunning-Schepers, Academic Medical Center, Amsterdam, the Netherlands

Free paper presentations

Direct economic costs of home and leisure injuries - requirements and limitations of international comparability, Robert Bauer, Sicher Leben, Vienna, Austria

Cost of injury in the Netherlands 1994, Willem Jan Meerding, Erasmus University, Rotterdam, the Netherlands

The burden of injuries: A first estimate for the Netherlands based on the DALY approach, Pieter Kramers, National Institute of Public Health and the Environment, Bilthoven, the Netherlands

Estimation of costs of ladder injuries, Bengt Springfeldt, Karolinska Institute, Sundbyberg, Sweden

Conclusions and recommendations from the workshops Rapporteurs of the four Workshops

General conclusions by Ed van Beeck

BREAKOUT SESSION ON ECONOMIC MEASURES
Bill Zamula, Economist, Consumer Products Safety Commission, Chair
Joan Harris, Special Assistant for Health Care, NHTSA, Reporter

There was a discussion of two different approaches, to estimating the cost of injury, the legal approach, which can provide an estimate of society's valuation of pain and suffering and the quality of life approach.

Possible new initiatives were discussed:

- The use of data sets that could be linked across several years in order to determine long term costs.
- The need to update the current estimate of the costs of motor vehicle crashes, which in some cases is based on 1982 - 1986 data.
- There is a need to develop cost numbers appropriate for different audiences.
- Analyses based on jury verdict data.
- Medical Expenditure Survey data from NCHS due next year. New analyses of these findings are possible.

Data limitations were also discussed:

- Primary payors are usually listed at admission. This may change by the time a patient is discharged.
- Data on several cost categories is extremely limited or non-existent, including physician costs, ancillary services such as physical therapist, pharmacy or durable medical equipment, and especially long term costs related to rehabilitation.
- Data in the HCIA data base is from e codes. There is a question about the number of states included, whether or not all services were included, and the years for which the data are available.
- The Medicare charge/reimbursement levels are not applicable to Medicaid.
- Caution was advised about using the word "cost." Cost is always based on the audience. "Cost" to a provider is not the same as "cost" to a payor.

BREAKOUT SESSION ON BEHAVIORAL EFFECTS
Catherine Gotschall, Director, Trauma Research, Children's National Medical Center, Chair
Susan McHenry, Emergency Medical Services Division, NHTSA, Reporter

The chair suggested that the discussion focus on three issues:

What research is needed?

What would help you in your work?

What has been helpful to you so far - instruments, methodologies, data bases and websites?

Research Needed

- Patient and family members views of quality of life decrements after injury.
- Psychosocial dimensions affected by long term/short term injury.
- Is a single number summary of Quality of Life psychosocial outcome appropriate?
- More comparisons with injured and controls.
- Studies of long term outcomes of traumatic brain injury, especially in children.
- What are the effects of psychosocial and behavioral diagnoses on physical function?
- Pediatric specific biomechanics focused basic science injury research, including normative data sets and impact tolerance.
- Impact of child's injury on overall family psychosocial issues
- Cost data associated with rehabilitation of motor vehicle injuries - effect of variables like depression and outcomes.
- Data on prevalence of "disabled" conditions.
- Follow-up studies measuring outcome at multiple intervals.
- Impact of EMS portion of care on quality of life and psychosocial outcomes - how can we separate this out or sort for this?
- Need to compare relative utility of various measures of looking at trauma outcome.
- Need to apply measure more broadly in uniform manner.
- Need to determine non-medical factors that influence outcomes; develop better "models" of outcome.
- A way of quantifying psychosocial effects for given injuries, or a way of showing that psychosocial outcomes are independent of physical injury, but the result of other factors.

What Would Help in Your Work?

- More developmental research on instruments.
- For children, information on return to previous activities, peer social interactions/difficulties.
- More complete databases across the country (out-of-hospital, EMS,) for example, so we can better use the models being suggested.
- Measures of specific relevance to studying traumatic brain injury outcomes.
- Access to local, regional or national databases linking injury data.
- More data to validate instruments like the SF-36.

- Commitment on the part of the medical profession to the collection of functional outcomes.
- Cost efficient methods for "tracking" trauma patients and their outcomes.
- Knowing who was active in the field so that I could network with them.
- Facilitated collaboration between like-minded colleagues in USA and internationally, also facilitated interdisciplinary networking - EMS, engineering, etc.
- Money.
- Better collaboration with other disciplines, including neuropsychology, psychology, surgery, schools of public health.
- Better knowledge of existing children quality of life measurement tools.

WHAT HAS HELPED SO FAR?

- Katz instrument.
- Multi-disciplinary studies.
- CIREN will be using SF-36 to collect data on approximately 350 motor vehicle crashes a year.
- Follow-up phone conversations.
- Websites - CDC and Harborview; People - MacKenzie, Luchter, Rivara.
- Getting together to discuss current research problems/findings with other scientists.
- Networking - the research process personal communication with authors of relevant papers, attendance at interdisciplinary meeting, particularly cross cultural and international comparisons.
- Instruments - SIP, methodologies - preference based measures, databases - hospital discharge data, trauma registries.
- Some good instruments already available on Quality of Life, not as much on psychosocial .
- San Diego study is a good start - need to address prehospital care and impact on depression.

BREAKOUT SESSION ON DATA
Sandy Johnson, National Center for Statistics and Analysis, NHTSA, Chair
Barbara Faigin, Chief, Planning and Analysis Division, Office of Safety Performance Standards, NHTSA, Reporter

This group considered priority issues in research and methods for assessing outcomes.

Priority Issues

- Cause/outcomes of injury from different vehicle system components (short and long term).
- Number of people with different impairments/disabilities (e.g. paraplegia, quadriplegia).
- Use insurance data for CPT codes, length of treatment, to measure treatment efficacy.
- Investigate false positives and negatives in data linkage.
- Develop analytic tools for longitudinal studies (current methods are inadequate).
- Investigate expanding billing data to include outcomes information.
- Expand beyond the anecdotal to analytical for family impacts.
- How to overcome the barriers to accessing reimbursement data and injury outcomes data.
- Improve definition of AIS to include outcome assessments.

Methods for Assessing Outcomes

- Probabilistic data linkage (with some problems of false positives and negatives).
- Relationships between different severity and outcome scales
- Values of prospective and retrospective studies for assessing injury outcomes.

PARTICIPANTS COMMENTS

In addition to the breakout sessions, attendees were asked to provide their thoughts concerning future research in injury outcomes, any thoughts concerning topics for any future conferences of this sort, as well as any other related comments. The contributions are presented here as close to verbatim as consistent with a uniform format and grouped into suitable topic areas.

General Comments

- It would be desirable to create an injury outcomes field including the interdisciplinary components represented at the conference.
- It would be desirable to integrate biomechanics into a tool for prospective analysis of injury outcomes based on models of injury occurrences.
- There is a need to address the issue of multiple trauma and the implications for severity and outcomes scales.
- There is a need to relate injuries to impact testing, for example, how well do regulatory injury criteria relate to real injury outcomes?
- It would be desirable to harmonize injury coding systems.
- There is need for more research on the impact of injuries on families. (2 people commented).
- Research is needed to address the facts that same pathology can result in different functional outcomes.
- There is a need for research to predict mortality. AIS, ISS, ASCOT, ICISS, TRISS etc. are based on hospital admission status.
- Study of long term health consequences, both physical and psychological, of non-life threatening injuries, such as whiplash and other soft tissue injuries should be undertaken.
- EMS and other process measures should be included along with injury event issues when measuring outcome

Health Status Measures

- There is a need to correlate health status measures with long term measures.
- There is a need for practical, useful early measures of injury severity.

Costs

- There is a need to discuss cost of care giving more.
- There is a need for an objective debate on monetizing QALYS to get comprehensive costs.
- More information is needed on rehabilitation costs.
- There is need for develop ways to integrate/correlate economic costs with non-economic measures such as FCI.
- There is a need to determine to what extent medical costs are the result of arbitrary cost accounting techniques for assigning joint or common costs.
- There is a need to estimate costs in an imperfect, poorly documented world of injury treatment.

QALYS, DALYS

- Several people suggested that it would be desirable to integrate QALYS, DALYS and FCI into a single analysis.
- There is a need to better determine utility weights and how they can be linked/reconciled with a willingness to pay approach.

Data

- It would be desirable to link CODES across states. (2 comments)
- There is a need to determine how individual privacy can be protected when constructing large data bases.
- It would be desirable to have an overview of relevant data bases.
- Linkages to areas such as insurance, social security and worker's compensation would be desirable.
- Linkage of data at the patient level would be desirable.
- Linkage of court data to determine effects of alcohol related injuries in terms of injury outcome and related costs would be desirable.
- Data quality issues such as handling variations in definitions, impact of missing data should be addressed.

Topics for Future Conferences on Injury Outcomes

- This meeting was really a motor vehicle injury outcomes meeting, and a full injury outcomes meeting should include participants who are knowledgeable in other injury costs.
- Any future conference should provide a short reference list and focus on updates rather than review of basics as was the case in this conference.
- Any future conference should limit presentation on FCI to validation/application. (2 comments)
- Any future conference should include presentations on the combined experiences of the CODES centers.
- Any future conference should include representatives from the large insurance companies. (3 comments)
- Trauma systems representatives should be included in any future meetings, including prehospital, emergency department and trauma center (CIREN).
- The relationship and status of CIREN activity should be included in any future conference.
- A session devoted to the methodologies of developing new quality-of-life/psychosocial measures would be desirable in any future conference.
- Any future conference should include interdisciplinary workshops so there could be a cross exchange of different sources of information or data by introducing computer access.
- Any future conference should include new injury coding scales such as NISS and AIS-99.
- Any future conference should include shorter presentations, with more time for questions and discussion.

- Any future conference should include presentations by motor vehicle industry associations (AAMA, AIAM) and the trial lawyers association (ATLA).
- It would be desirable for any future conference to have handouts including full instrument for each tool discussed.
- Any future conference should include a session on pediatrics.
- Any future conference should include a focus on the interdisciplinary process, particularly the interface between epidemiology, biomechanics and outcomes so that representatives of each element in this chain can benefit from new directions/concepts.
- Any future conference should include a detailed focus on the elements that predict variable functional outcomes within specific homogeneous injury groups.
- New technologies such as high end computer modeling of projected/predicted outcomes based on multifaceted elements including detailed mechanism, premorbidity, resource utilization leading to functional outcome should be discussed at any future conference.
- There is a need for a consensus conference that would result in recommendations that the community could then follow.
- Any future conference should address confidentiality and other data correlation issues.
- Any future conference should include more information on data sources and how to get them.
- Any future conference should include more biomechanics and vehicular design and engineering safety issues.
- Differences in children, adults, and older populations should be discussed at any future conference.
- Breakout sessions were constrained by time. Future breakout sessions could be working groups that go into in-depth discussions of specific items such as FCI or SF-36 or economic analysis.

SYNTHESIS

Stephen Luchter, Senior Policy Advisor, National Highway Traffic Safety Administration

This report is a summary of the material presented at June 15/16 meeting edited only for consistent format. This section, however, is different - it attempts to define the state of knowledge in injury outcomes using a synthesis of the results of the conference as a starting point, focusing on identifying gaps in this knowledge base that should be considered for closure. Topics are identified at two levels: those related to development of methods of measuring injury outcomes and those related to questions that are either unanswered or where the answers are not current. For convenience in presentation the section is organized into five parts: economic outcomes, physical outcomes, psychosocial outcomes, data issues, and general topics.

Economic Outcome Measures

Methods for determining the economic outcomes of injury are well established with a solid base in theory for both the human capital and willingness to pay approaches. Questions of when (or if) to apply certain concepts within these methods remain, such as the use of friction costs within the human capital rubric. Such questions do not indicate the need for further methodological development, but rather that experts need to use judgments in the application. There are, however, a number of questions that merit consideration for further work:

1. The last comprehensive estimate of the cost of injuries in the United States is nearly 15 years old. It was based mostly on data from the early 1980's with some data indexed from even earlier times. So much has changed since then that an analysis based on current conditions should be given a high priority, realizing that this is potentially a large and significant effort.
2. One cost category that bears little resemblance to the situation in the early 1980's is the cost of medical care following injury, largely due to the greatly increased market share of managed care with its totally different cost model. Also, accurate data on several cost categories were not available when developing the earlier estimates, including professional fees paid to physicians, chiropractors, physical and occupational therapists, etc., the costs associated with informal care giving, the costs of drugs used in treatment of injury, and the medical costs associated with rehabilitation. The medical costs related to injury are particularly important from a public policy viewpoint, especially in light of the changing paradigms concerning public assistance. An analysis of the costs of medical care resulting from injury based on current conditions is very important and should be undertaken, even if the larger effort described above cannot be considered at this time for resource reasons.
3. Not only are the medical costs associated with rehabilitation largely unknown, little is known about any of the other costs associated with rehabilitation following injury. There is a concern that they may be quite large. This problem has been recognized for some time and should be considered for higher priority than it has received.
4. A current analysis of the sources of payment for the costs resulting from injury is warranted due to the dramatic revisions in public assistance programs and changes in taxation rates since the last estimates were made.

5. There are no good estimates of the cost of injuries to families. Anecdotal evidence suggest that these costs may be large. A thorough study is justified.

Physical Outcome Measures

For many purposes it is desirable to be able to quantify changes in what people can do post-injury. Existing health status measures include relative answers to many of these questions, but not in a form that can be used directly as inputs to measures such as Quality Adjusted Life Years (QALYS) or Disability Adjusted Life Years (DALYS).

One method being developed for measuring physical outcomes of injury directly is the Functional Capacity Index (FCI). This Index can be used to estimate life years at reduced capacity, shown as Life-years Lost to Injury in some publications and recently described as Capacity Adjusted Life Years (CALYS) as a parallel to the QALY and DALY concepts. The Index has been shown to be a valid instrument for measuring injury outcome and differences between outcomes predicted by an expert panel and observed outcomes have been identified. Plans for gathering empirical data are being completed. Development of a pediatric version of this index is underway. Methods for measuring injuries in the geriatric population remain to be developed as are methods for estimating the reduction in life expectancy following injury, how to add time since injury as a variable and how to use the Index when measuring the effect of multiple injuries. Also justified is development of an ICD version of the Index, as the present Index is based on injury descriptors found in the AIS '90 dictionary.

Once fully developed there are a number of potential applications for these measures, including mapping the effects of different causes of injury and comparing injury outcomes with those of major diseases.

Psychosocial Outcome Measures

It has long been suspected that serious psychosocial changes can result following an injury. Preliminary results presented at this conference show that, based on well established clinical methods, a significant portion of injured people experience depression or post traumatic stress disorder/syndrome following injury, and that these conditions take considerable time to abate. This research also suggests that preexisting emotional state may have a greater effect on the behavioral changes following injury than the particular injury. The literature shows anecdotal evidence of other psychosocial changes following injury, including family breakups, reduced performance on the job or in school, and substance abuse among other effects. This evidence also shows that these psychosocial changes can occur to persons involved in the same injury event but who were not themselves injured, as well as to family members or others who were not even involved in the injury event. Unfortunately, no coherent model of the overall problem exists. Development of such a model merits high priority as a precursor to development of methods of determining psychosocial outcomes in a form suitable for policy analysis applications.

Once suitable methods for measuring psychosocial outcomes of injury have been developed there are a number of potential applications. One for early consideration would be a

mapping of the psychosocial effects of injury on society of different injury types with subsets focusing on different parts of the population such as those injured, those not injured but involved in the injury event, those not involved in the injury event either related to the injured person such as family members or witnesses to the injury event.

Data Issues

A major advance in the methods of applying injury data is the ability to link different data bases. This has resulted in the development of state level population based data sets. These methods have successfully linked with insurance, social security, worker compensation, and court data, among others.

Among the potential applications of linked data is development of aggregated databases derived from the output of linking numerous data sources. From this regional and possibly national level aggregate data related to injury outcomes could be developed. Another possible application would be linking data across several years in order to determine long term trends.

General Topics

Most approaches to measuring injury outcome are based on single injuries. Methods have been devised to estimate the effect of multiple injuries, but some of them are not fully satisfactory. For example using maximum Abbreviated Injury Score (AIS) for injury severity does not tell the relative severity of the combination of several injuries. The NISS approach appears to be an improvement over the ISS but this is a new measure and further application is needed to demonstrate its long term utility.

An important application of measures of injury outcomes is as a tool to use in designing prevention countermeasures. People do not volunteer to be injured. As a result, countermeasure design is accomplished largely via the use of mathematical models, cadavers, dummies and test devices. Each of these approaches has a number of practical advantages, however the relationship between the outcomes experienced by real people with real injuries and what happens when these surrogates are used as intermediaries merits refinement.

One model of overall injury outcome presented at the conference shows that injury outcome is multi-dimensional, with economic, physical and behavioral components. However, as one delves deeper into the issues, it is apparent that there are second order terms. For example, if an injured individual uses all of their economic resources to care for themselves there could well be some behavioral effects. Also, there may be a relationship between psychosocial effects and differences in the physical effects of the same pathology on different people. Investigation of such issues cannot be considered high priority at this time as the basic issues are not fully understood, but they should be included in any long term plan to understand the overall field.

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