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Measuring the Severity of Physical Injury Among Assault and Homicide Victims

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Criminologists seldom have attempted to measure the severity of physical injury to victims of aggravated assault and homicide, even though it is significant to many of their research efforts. Previous attempts have been neither medically accurate nor medically acceptable. In this paper the author discusses the shortcomings of these efforts and introduces an alternative method which is valid, reliable, and medically acceptable. In addition, the author discusses its applicability to research the impact of medical intervention on violent criminal assault, on factors which contribute to the severity of assaultive injury and the lethal outcome of violent assault, on specific questions regarding the patterns of offending and victimization, and on the administration of criminal justice.

KEY WORDS: injury severity; injury severity scales; victims; homicide; aggravated assault; medical care.

1. INTRODUCTION

For two decades now criminologists have been aware that the patterns of aggravated assault and homicide are similar (Pittman and Handy, 1964; Pokorny, 1965). Profiting from these observations, Zimring (1972), in his attack upon the legal assumption that lethal assault can be distinguished from nonlethal assault on the basis of criminal intent, argues that the dangerousness of the weapon employed in assault may be a greater determinant of lethal outcome than any single-minded intention of the offender. He concludes, therefore, that the patterns of many homicides and aggravated assaults are similar because of the ambiguous intent of the assailant.

Other criminologists, reiterating Pittman and Handy's (1964) conclusion, suggest that emergency medical intervention may play a substantial role in preventing the lethal outcome of many assaults (Barlow, 1983; Rose, 1979; Hawkins, 1983). This argument also suggests that the patterns of the

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two offenses are similar. However, in this argument the two offenses differ to some degree on the basis of variations in emergency medical intervention.

The first argument asserts that since the patterns of the two offenses are very similar, in many ways the choice of firearms determines outcome, with the larger-caliber weapon producing higher rates of mortality. Implicit here is that the distinction between an assault and a homicide is in the severity of the injury inflicted. In contrast, the assumption in the latter argument is that the distinction between many aggravated assaults and homicides is not the severity of the injury inflicted but, rather, the factors which affect the receipt of adequate medical intervention.

Important to both of these arguments, as well as to other potential research questions concerning violent assaultive crime, is an accurate assessment of the severity of physical injury. The purpose here is to discuss the various ways criminologists have measured injury severity, to introduce an alternative method of accurately measuring such injuries, and to discuss the validity, reliability, and potential applicability of this alternative to criminological research.

2. CRIMINOLOGICAL EFFORTS TO MEASURE THE SEVERITY OF INJURY

For over 20 years criminologists have applied psychological scaling techniques in the measurement of crime severity (Bridges and Lisagor, 1975; Erickson *et al.*, 1977; Figlio, 1975; Gottfredson *et al.*, 1980; Riedel, 1975; Rossi *et al.*, 1974; Sebba, 1980; Sellin and Wolfgang, 1964; Sheley, 1980; Wagner and Pease, 1978; Wellford and Wiatrowski, 1975) and in the measurement of sentencing and punishment severity (Allen and Anson, 1985; Buchner, 1979; Erickson and Gibbs, 1978, 1979; Sebba, 1978). The seminal work in this area was conducted by Sellin and Wolfgang (1964), who surveyed criminal-justice professionals about the perceived severity of 141 descriptive criminal events. Their goal was the development of a unidimensional scale to measure the relative severity of a variety of offenses. More recently, a national survey of 60,000 persons was conducted to determine how the general public ranks the seriousness of 204 illegal acts [see United States Department of Justice (USDJ), 1984]. Included in these two studies were descriptions of criminal events which resulted in physical injuries to victims.

Although these scales are valuable in determining the relative severity of injury crimes among a wide variety of criminal acts, they are not useful as independent assessments of injury severity from a physiological standpoint. The primary reason is that the basic concept of unidimensionality in scale development presumes a single, fundamental dimension underlying

the items to be scaled (Gordon, 1977). In the present case the underlying concept involves human actions which are unified by their unlawful nature. The underlying dimension is one of perceived social harm and/or moral reprehensiveness. Hence, the severity of the various acts is based on the degree of perceived social harm or reprehensiveness, not necessarily on the degree of physical harm suffered by the victim. In addition, for those acts which included physical injury, the degree of perceived severity was influenced strongly by the situational context of the event, the characteristics of the offender and victim, the specific intent of the offender, and the culpability of the victim.

While there have been numerous attempts to measure crime severity in the above manner, there have been few efforts by criminologists to assess the degree of physical harm experienced by victims of violent crime. The attempts made to date have been neither medically accurate injury descriptions nor medically acceptable assessments of injury severity. The least acceptable method used in criminological research to measure injury severity is whether or not the victim requires hospitalization. This method was used by Pittman and Handy (1964) and Block (1974), and while this approach certainly taps the domain of injury severity, it contains too much error. Although an assault victim may require hospitalization, it may often be for medical rather than trauma related reasons. That is, the admission may be due not to a viable threat to life but, rather, to the need for further monitoring of recovery or for further stabilization of the patient. Thus, while the most severely injured victim will certainly require hospitalization, this alone does not provide a differentiation of the degrees of injury severity. In addition, this technique is influenced by factors unrelated to injury severity. For example, if two victims received identical injuries and one obtained emergency treatment within 15 minutes and the other received treatment after a 90-minute delay, the latter victim would more likely require hospitalization than the former. The reason for the hospitalization would be due not to the injury alone but to a diminished clinical picture resulting from the delay in time between injury and intervention. Finally, when used as a measure of injury severity the hospitalization criterion may contain built-in biases. Two examples illustrate the problem. First, it is often suggested that the severity of injury is one of the determinants of whether or not a victim officially reports the offense (Lizotte, 1985). However, as pointed out by Cook (1985) and Lizotte (1985), if an injured crime victim presents to an emergency room, the vast majority of states requires by statute that physicians and other hospital personnel report suspected criminal offences to police, an obligation taken seriously by the vast majority of medical professionals. Hence, using the hospitalization criterion as a measure of injury severity in this instance is not valid since the presence in an emergency

room enhances the likelihood of official police contact independent of the victim's willingness to report the offense. In the second example, it has been suggested in a recent United States Department of Justice (1983) document, *Report to the Nation on Crime and Justice*, that the severity of an assaultive injury increases the more intimate the relationship between the victim and the offender. However, it may be that intimates are more likely to obtain or permit the victim to obtain treatment for injuries (many of which may ultimately be less severe in nature) than are nonintimates, thus invalidating the hospitalization criterion as a useful measure of injury severity.

A second approach to measuring the severity of injury involves identifying the number and location of wounds to the victim. This technique was used by Barlow (1983), Vinson (1974), and Zimring (1972) and represents an improvement over the hospitalization criterion. Most trauma victims do receive multiple injuries, and intuitively, the location of a wound(s) would be an important consideration in assessing the severity of injuries. Wounds to the extremities are usually less severe than wounds to the thorax and head. However, this approach still represents a crude assessment of injury severity since many injuries to the extremities are, in fact, relatively severe. In addition, these researchers devised no methodologically rigorous scheme to grade the severity of various combinations of wounds and anatomical regions.

Finally, Zimring (1972) combined the firearm caliber with the number and location of wounds to assess the overall severity of injury. While this may appear to be an improvement over the second method of assessing injury severity, it assumes that the firearm caliber is a determinant of injury severity and that the injury mechanism is an accurate indicator of injury severity. Also, here again there is no scheme to grade the various combinations of wounds, locations, and caliber variations.

As is evident from the discussion above, criminologists have confused the concept of injury. An injury is the "... deformation of tissues beyond their failure limits, resulting in damage of anatomic structures or alteration in function" (Committee on Trauma Research, 1985). Criminologists have measured injury by dichotomizing it into injury versus noninjury; by describing specific lesions such as broken bones and teeth, lacerations, and cuts; by classifying the mechanism of injury such as gunshot, knife, or club; by describing anatomical locations of wounds such as chest, abdomen, or head; and by classifying outcomes such as bruises, swelling, unconsciousness, and death. While some of these methods are unacceptable, the common mistake is to mix the various schemes. For example, Lentzner and DeBerry (1980) and McLeod (1983) classify injuries by mechanism of injury, lesions, anatomical location of injury, and outcome. While these are useful in describing injuries, they must be placed into a coherent classification scheme

which allows meaningful determinations of severity. It should be noted that criminologists are not the only ones confused about injury. Those in the health professions have tended to utilize the schemes mentioned above, with little thought given to the development of a consistent and accurate classification scheme.

The obvious difficulty for criminologists is how to describe and classify injuries accurately and how to assess their severity absent medical knowledge. Presented below is a discussion of a medically acceptable alternative to the above methods, which requires no medical training. However, it does require access to medically accurate injury descriptions (this topic is discussed below in more detail). This is followed by a discussion of its validity, reliability, and potential applicability to important questions in criminology.

3. THE ABBREVIATED INJURY SCALE AND THE INJURY SEVERITY SCORE

The Abbreviated Injury Scale (AIS) is a lesion-specific method for distinguishing injury severity (Jorgensen, 1981). The origins of the scale date from 1966 when the American Medical Association (AMA), through its Committee on the Medical Aspects of Automotive Safety, began an investigation of existing injury scaling systems. Then in May 1969 physicians, researchers, and engineers finalized the initial development of an injury scale that was deemed both medically accurate and philosophically acceptable to a wide array of medical subdisciplines. The first AIS was published in 1971 under the auspices of the Joint Committee on Injury Scaling (1980), composed of representatives from the AMA, the Society of Automotive Engineers, and the American Association for Automotive Medicine (Petrucelli *et al.*, 1981). Since then the AIS has been revised twice and has become the officially sanctioned injury data collection instrument for all U.S. federally funded vehicular crash investigation teams. In addition, it has become officially adopted by similar programs in Australia, Canada, England, France, Germany, and Japan (Mackenzie *et al.*, 1981). Although the AIS was originally developed to measure the severity of injuries resulting from road-related injuries (to both vehicular occupants and pedestrians), it has been introduced as a worthwhile means of measuring traumatic injuries from a variety of injury mechanisms (Petrucelli, 1982).

3.1. Features of the Scale

The AIS was developed initially on the basis of clinical judgments by physicians (Cayten and Evans, 1979). The term "abbreviated" does not refer to a truncated listing of specific injuries. Rather, it refers to the assignment

A.I.S. SCORE	1 MINOR	2 MODERATE	3 SEVERE, NOT LIFE-THREATENING	4 SEVERE LIFE-THREATENING	5 CRITICAL, SURVIVAL UNCERTAIN
EXTERNAL	**Abrasion / contusion** · superficial or unspecified / $\leq$ 25cm^2 on face or 50 cm^2 on body **Superficial or unspecified laceration** i) not into subcutaneous tissue regardless of length ii) into subcutaneous tissue but $\leq$ 5 cm on face or $\leq$ 10 cm on body **1° burn up to 100%** **2° or 3° burn < 6% total body**	**Major abrasion / contusion** **> 25 cm^2 on face** **> 50 cm^2 on body** **Deep laceration (into subcutaneous tissue) and > 10 cm on body or > 5 cm on face** **2° or 3° burn to 6-15% total body**	**2° or 3° burn to 16-35% total body**	**2° or 3° burn to 26-35% total body**	**2° or 3° burn to 36-90% total body**
HEAD (includes FACE (F))	**Awake on admission or initial observation** · no prior unconsciousness but may have headache / dizziness 2° to head trauma **Ear canal injury** **Eyes (F)** · conjunctiva abrasion / contusion / laceration · corneal abrasion / contusion · lid abrasion / contusion / laceration · vitreous / retina / canaliculis (tear duct) laceration · choroid rupture · uvea injury **Gingiva (F)** (gum) contusion / laceration **Lip (F)** contusion / laceration (no matter how extensive) **Mandible (F)** · fracture unspecified · ramus fracture **Nose (F)** fracture **Teeth (F)** avulsion / dislocation (loosened) / fracture **Superficial tongue (F)** laceration	**Awake on admission or initial observation** · prior unconsciousness but length of time unspecified · amnesia (no recollection of crash) · unconsciousness < 15 min **Lethargic, suporous, obtunded on admission or initial observation (can be aroused by verbal stimuli)** · no prior unconsciousness · unconsciousness < 15 min **When level of consciousness on admission or initial observation is unkown** · unconsciousness < 15 min **Medical diagnosis listed as concussion with no other description** **Fracture of vault** (frontal, occipital, parietal sphenoid, temporal or unspecified) closed, undisplaced, diastatic, linear, simple, unspecified **Ear** · inner / middle ear injury · ossicular bone dislocation · tympanic membrane rupture · avulsion of pinna (outer ear) **Eye (F)** · cornea laceration · sclera laceration / rupture **Alveolar ridge (bone) (F)** fracture with or without tooth injury **Avulsion gingiva / lid / lip (F)** **Mandibular fracture (F)** · ramus if open / displaced / comminuted · body with or without ramus involvement · subcondylar **Maxilla fracture (F)** closed / unspecified / Le Fort I / zygomatic fracture **Tongue (F)** deep + /or extensive laceration **Nose (F)** fracture open / displaced / comminuted	**Awake on admission or initial observation** · prior unconsciousness but length unspecified / amnesia · unconsciousness 15 mins with neurological deficit · unconsciousness 15-59 mins **Lethargic, stuporous, obtunded on admission or initial observation (can be aroused by verbal stimuli)** · no prior unconsciousness / unconsciousness < 15 min with neurological deficit · unconsciousness 15-59 min · prior unconsciousness / loss of consciousness unspecified **Unconsciousness on admission or initial observation (unresponsive to verbal commands)** · length of unconsciousness unspecified · unconsciousness < 1 hr **When level of consciousness on admission or initial observation is unknown** · unconsciousness 15-59 min · unconsciousness < 15 mins with neurological deficit **Fracture of base** (basilar ethmoid, orbital roof, sphenoid, temporal) without CSF leak **Comminuted compound, depressed or displaced fracture of vault** **Cerebellum or cerebrum** · contusion · injury involving any of the following but no further anatomic description (subarachnoid hemorrhage, edema, brain swelling, subpial hemorrhage, hygroma, ischemia, infarction) **Zygomatic fracture (F)** open / displaced / comminuted **Eye (F)** · avulsion · optic nerve avulsion / laceration · tear **Mandibular fracture (F)** · ramus involvement / mandible fracture · subcondylar / body with or without ramus involvement for any one displaced / comminuted **Orbit fracture open / displaced, comminuted (F)** **Le Fort II (F)**	**Awake on admission or initial observation** · unconscious 15-59 min with neurological deficit · lethargic, stuporous, obtunded on admission or initial observation (can be aroused by verbal stimuli) · unconsciousness 15-59 min / prior unconsciousness for unspecified length of time / unspecified loss of consciousness involving neurological deficit **Unconscious on admission or initial observation (unresponsive to verbal commands)** · 1-24 hr (includes 1 calender day when hrs cannot be estimated) · appropriate movements but only upon painful stimuli (no matter the length of unconsciousness) · length of unconsciousness unspecified / unconscious < 1 hr involving neurological deficit **When level of consciousness on admission or initial observation is unknown, but unconscious for:** · 1-24 hrs (includes 1 calender day when hrs cannot be estimated) · 15-59 min involving neurological deficit **Fracture of base** (basilar ethmoid, orbital roof, sphenoid, temporal) with CSF leak or pneumocephalus **Fracture of vault** (frontal occipital, parietal, sphenoid, temporal, unspecified) open, / dura torn, / CSF leak, / pneumocephalus or brain exposed **Cerebellum or cerebrum** · laceration · **hematoma**, epidural / subdural $\leq$ 100 cc, or unspecified · hematoma, intracerebral, intracerebellar (including petechial and subcortical hematoma) **Le Fort III (F)**	**Unconscious on admission or initial observation (unresponsive to verbal stimuli)** · Inappropriate movements (decerebrate, decorticate, flaccid, no response to pain—no matter the length of unconsciousness). · 1-24 hr (includes 1 calender day when hours cannot be estimated) / appropriate movements but only upon painful stimuli (no matter the length of unconsciousness with neurological deficit **When level of consciousness on admission or initial observation is unknown, but unconscious for:** · 1-24 hrs (includes 1 calender day when hours cannot be estimated) with neurological deficit · > 24 hrs **Brain stem** · compression / contusion / injury involving hemorrhage **Cerebellum or cerebrum** · hematoma, epidural / subdural > 100 cc · diffuse brain injury (white matter shearing injury)
NECK	**Pharynx** contusion / laceration / puncture / rupture **Throat (inner soft tissue)** abrasion / contusion / laceration (not involving major artery) **Tracheal** contusion	**Pharynx** contusion with hematoma / laceration with hemorrhage **Contusion** / esophagus / larynx / thyroid gland	**Trachea** crush **Thyroid gland** laceration	**Laceration** of trachea / carotid artery / subclavian artery **Larynx** crush / fracture / laceration	**Esophagus / larynx / trachea** avulsion / rupture
THORAX	**Rib** contusion / fracture	**Rib** fracture open / displaced / >2 adjacent ribs up to flail chest **Sternum...fracture**	**Lung / pericardium** contusion with or without unilateral hemothorax **Lung** laceration superficial or unspecified **Unilateral hemothorax / pneumothorax** with rib cage or thoracic cavity injury **Sternum fracture...**open / displaced / comminuted	**Chest wall (soft tissue)** perforation / puncture **Lung contusion** with hemomediastinum / pneumomediastinum / bilateral hemothorax or pneumothorax **Myocardium...**contusion **Pericardium...**contusion with hemomediastinum / pneumomediastinum or tamponade / perforation / puncture / rupture / laceration / bilateral hemothorax or pneumothorax **Bilateral hemothorax / pneumothorax** **Hemomediastinum / pneumomediastinum** **Flail chest ("sucking chest" wound)** **Lung laceration** superficial or unspecified with hemothorax / pneumothorax **Inhalation burn**	**Laceration...**aorta / bronchus / coronary artery / lung (deep + /or extensive) / myocardium (including multiple chambers) / pulmonary artery or vein / superior or inferior vena cava / pericardium if involving hemomediastinum / pneumomediastinum or tamponade **Puncture / rupture** of aorta / intracardiac valve or septum / myocardium (involving multiple chambers) / superior or inferior vena cava / pericardium if involving hemomediastinum / pneumomediastinum or tamponade **Perforation** of aorta / bronchus / myocardium / pericardium if involving hemomediastinum pneumomediastinum / tamponade **Rupture bronchus** **Inhalation burn** requiring mechanical respiratory support **Myocardium contusion** if severe or involving hemomediastinum or pneumomediastinum

A.I.S. SCORE	MINOR	MODERATE	SEVERE, NOT LIFE-THREATENING	SEVERE LIFE-THREATENING	CRITICAL, SURVIVAL UNCERTAIN
ABDOMEN/ PELVIC CONTENTS (*includes all described in parenthesis)	**Superficial or unspecified laceration / perforation** of abdominal wall (no organ involvement) **Abrasion / contusion / superficial or unspecified Laceration or perforation** of scrotum / vagina / vulva / perineum **Penis...contusion** **Scrotum...rupture**	**Abdominal wall avulsion** **Deep + /or extensive laceration or perforation** of abdominal wall (no organ involvement) / scrotum **Stomach contusion** **Ureter** contusion / superficial or unspecified laceration	**Abdominal wall musculature rupture** **Contusion** of *biliary tract (Gall Bladder, hepatic, cystic, & common bile ducts) / colon / duodenum / jejunum / ileum / kidney (with or without hematuria) / liver / bladder / mesentery (omentum) / pancreas / peritoneum / rectum / spleen / urethra / uterus **Superficial or unspecified laceration / perforation** of bladder / penis / ureter / diaphragm **Deep + /or extensive laceration / perforation** of perineum / ureter / vagina / vulva **Avulsion** of scrotum / ureter **Retroperitoneum**...injury involving hemorrhage or hematoma	**Superficial or unspecified laceration / perforation** of biliary tract* / colon / duodenum / jejunum / ileum / kidney / liver / pancreas / peritoneum / rectum (superficial over entire rectal wall, extraperitoneal) **Deep + /or extensive laceration / perforation** of bladder / mesentery / penis / stomach / urethra / uterus **Avulsion** of bladder / mesentary / penis / spleen / stomach / testes / urethra / uterus (unpreghant or 1st trimester) / ovary **Rupture** of spleen / stomach / urethra / uterus (unpregnant or 1st trimester) / bladder (intraperitoneal) **Rupture / tear** ovarian / fallopian tube **Spleen laceration**	**Avulsion / deep + /or extensive laceration / perforation / rupture** of biliary tract* / colon / duodenum / jejunum / ileum / kidney / liver / pancreas (with or without duodenum involvement) **Deep + /or extensive laceration / rupture** of peritoneum / rectum **Intra-abdominal or intrapelvic major vessel laceration** **Uterus** (in 2nd or 3rd trimester) avulsion / rupture
SPINE	**Acute strain with no fracture or dislocation** cervical / thoracic / lumbar spine	**Dislocation (subluxation) + /or fracture** spinous or transverse process (or unspecified) of cervical, thoracic, lumbar spine **Minor compression fracture** T_{1-12} / $L_{1-5} \leq 20\%$ loss in height of anterior vertebral body / unspecified)	**Cervical cord** contusion with transient neurological signs (muscle weakness, paralysis, loss of sensation) **Disc herniation (rupture) with nerve root damage** of cervical / thoracic / lumbar spine **Dislocation (subluxation) + /or fracture** of / lamina / body / facet / pedicle / odontoid of cervical / thoracic / lumbar spine **Nerve root / trunk brachial plexus / lumbar plexus / sacral plexus** avulsion / laceration / rupture, injury with unknown lesion **Compression fracture of more than one vertebrae + /or > 20% loss of height of anterior body** T_{1-12}/L_{1-5}	**Cervical cord lesion** incomplete with preservation of significant sensation + /or motor function	**Cervical cord** crush / laceration or total transection with or without fracture + /or dislocation C_4 or below **Complete cervical cord lesion** (quadriplegia or paraplegia) **Crush / laceration / total transection (paraplegia)** of cord / cauda equina
EXTREMITIES & BONY PELVIS	**Contusion / sprain** of acromioclavicular joint / elbow / shoulder (glenohumeral joint) / sternoclavicular joint / wrist (carpus) / ankle **Contusion** fibula / knee **Sprain** finger / foot / hip / toe **Fracture / dislocation** finger / toe	**Dislocation / laceration into joint** of acromioclavicular joint / elbow (dislocation of radial head) / hand (laceration involving flexor or extensor tendons) / sternoclavicular joint / wrist / heel (dislocation subtalar; laceration involving Achilles tendon) / patella (laceration or rupture patellar tendon) **Fracture** of clavicle / acromion / hand (carpal or metacarpal) / humerus / radius (including Colles) / scapula / ulna / fibula (head, neck, shaft, or lateral malleolus) / foot (metatarsal talar, tarsal or unspecified) / heel (calcaneus) patella / pelvis (closed or unspecified with or without dislocation of any of the combination of the ilium, ischium, coccyx, sacrum, pubic ramus) / tibia (shaft, malleolus, plateau, condyles) **Laceration into joint** of shoulder / ankle / knee **Muscle** avulsion or laceration of major muscle tendon of upper & lower (except patella & Achilles) extremities **Nerve laceration** of upper (median, radial, ulnar) or lower (femoral, tibial, sciatic or peroneal) extremity **Dislocation** of foot (subtalar, transtarsal, or transmetatarsal) **Laceration or rupture** of distal biceps tendon **Biceps** muscle rupture **Amputation / crush** of finger / toe **Acromioclavicular** separation **Contusion** of fibula with peroneal nerve injury ("footdrop") **Rupture** of collateral or cruciate ligaments of the knee	**Crush** of acromioclavicular joint / arm / forearm / elbow / hand / shoulder / sternoclavicular joint / wrist / ankle / foot / heel / knee / below knee **Amputation** upper extremity above or below elbow / hand / foot / heel / lower extremity below knee (traumatic; partial or complete) **Dislocation** of shoulder / wrist (radiocarpal, intercarpal, pericarpal) / ankle / knee / elbow (if involving olecranon) / hip (with or without fracture of acetebulum, femoral head, neck or intertrochanteric) **Fracture** of humerus / radius (including Colles) / ulna (with any one or combination of open, displaced, comminuted or involving radial nerve) / femur (condyle, head, neck, shaft with or without sciatic nerve involvement). **Fracture** of tibia / fibula / or pelvis (closed or unspecified with or without dislocation, of any one or combination of the following: ilium, ischium, coccyx, sacrum, pubic ramus) with any one or combination of open, displaced or comminuted **Sacroiliac** fracture + /or dislocation **Symphysis pubis** separation (fracture) **Knee**...rupture of collateral or cruciate ligaments **Ankle**...rupture of collateral ligaments + /or Achilles tendon **Laceration** of axillary / brachial femoral / popliteal artery **Nerve laceration** of upper (median, radial, ulnar) or lower (femoral, tibial, sciatic peroneal) extremity involving $\geq$ 2 nerves in same extremities **Muscle avulsion or laceration** of multiple major muscle tendons in upper and lower (except patella or Achilles) extremities **Complete patellar tendon** laceration or rupture	**Pelvis** ... crush **Above knee crush / amputation** (traumatic partial or complete)	

A.I.S.6 - *Maximum Injury* *- Automatically Assigned I.S.S.-75*	
EXTERNAL	- 2° or 3° burn including incineration $\geq$91% T.B.S.
HEAD	- crush or ring fracture crush/laceration brain stem (hypothalamus, medulla, midbrain, pons.)
NECK	- decapitation
THORAX	- total severence aorta chest massively crushed
ABD./PELVIC CONTENTS	- torso transection
SPINE	- cord crush/laceration or total transection with or without fracture C-3 or above

Source: Trauma Chart in Greenspan, L., McLellan, B. A., and Greig, H. (1985) "Abbreviated Injury Scale and Injury Severity Score: A Scoring Chart." *Journal of Trauma*, Vol. 25, No. 1, pp. 60-64. This chart is included only for descriptive purposes. It is not intended for use by those unfamiliar with the AIS scoring system.

of a single ordinal code value to one of over 500 specific injury descriptions. The scale values range from one to six, with one representing a minor injury and six representing a virtually unsurvivable maximum injury (see Fig. 1).

Injuries are categorized into six body regions: head, neck, thorax, abdomen and pelvic contents, spine, and extremities and bony pelvis. In addition, the AIS includes a section entitled "External," which categorizes integumentary injuries, including burns. Injury descriptions are listed in alphabetical order within each region to aid the coder in locating the specific injury and the corresponding injury scale value.[2]

The AIS has been described as a measure of injury severity that considers five dimensions: threat to life, energy dissipation, permanent disability, treatment period, and incidence (Eastham, 1983). However, research shows that threat to life is the sole dimension of injury severity measured by the AIS (Huang and Marsh, 1978). Hence, the AIS is based on bodily insult, not on the outcomes of injury such as death, blindness, ache, pain, deafness, obstruction, spontaneous abortion, hemorrhage, asphyxia, etc., or on the injury mechanism such as falls, pedestrian accidents, automobile crashes, burns, striking with a blunt instrument, penetrating injuries, etc.[3]

Most trauma victims are the recipients of multiple injuries. The AIS, although it scores specific injuries individually, serves as the basic data for the assessment of multiple injury severity. Baker *et al.* (1974) developed the Injury Severity Score (ISS) as a methodoligical tool for the assessment of multiple injuries based on the AIS scale values for individual injuries. These researchers modified slightly the arrangement of the bodily regions employed by the AIS: (1) head and neck, (2) face, (3) chest, (4) abdominal or pelvic content, (5) extremities or pelvic girdle, and (6) external. The ISS value is derived by summing the squares of the highest AIS values in each of the three most severly injured body regions. This scale contains 44 values ranging from a score of 1 to a score of 75 representing a discontinuous nonlinear scale. Individuals receiving an AIS score of 6 are automatically assigned an ISS value of 75.

For example, when rating a victim who received two gunshot wounds to the leg and abdomen, resulting in perforations of the brachial femoral artery and deep perforations of the abdominal wall and the stomach, the ISS would be calculated in the following manner:

[2]The National Technical Information Service has reproduced the *Injury Coding Manual*—1980 by Petrucelli *et al.* (1980) for distribution. This manual contains the AIS injury descriptions by body region, the corresponding severity codes, the ISS body regions, an anatomical index, hospital abbreviations and symbols, and a medical glossary.

[3]The coding of head injuries represents the only exception to this general edict. For these injuries both anatomic lesions and level of consciousness may be used to assess injury severity.

Injury	*Body region*	*AIS value*	$(AIS)^2$
1. Laceration of brachial artery	Extremities & bony pelvis	3	9
2. Deep perforation of stomach	Abdomen & pelvic content	4	16
3. Deep perforation of abdominal wall	Abdomen & pelvic content	2	—
			ISS = 25

In this example, only the first two AIS values are used to calculate the ISS. Since the second and third injuries are contained within the same body region, only the more severe (AIS = 4) injury is included.

As further example, a victim who was stabbed in the chest, resulting in an extensive laceration of the aorta, would be scored in the following manner.

Injury	*Body region*	*AIS value*	$(AIS)^2$
Extensive laceration of the aorta	Thorax	5	25
			ISS = 25

These two examples illustrate the usefulness of the ISS method in accounting for the overall severity of relatively less severe multiple injuries compared to a relatively more severe single injury.

Somers (1981, 1983) developed the Probability of Death Score (PODS) as an alternative to the ISS. Also employing the AIS, the PODS is based on the two highest AIS values, selected without regard to body region. Somers (1981) utilizes a stepwise logistic regression technique to calculate weighting factors (betas) for the two highest AIS values and defines PODS as the sum of the weighted variables and a constant value (alpha). The PODS ranges from -10.0 to $+10.0$. Using this technique researchers can calculate the probability of death for individual victims and can estimate the person years lost due to traumatic death.

Since the probability of survival from a traumatic injury may be substantially affected by the age of the insulted party, both the ISS and the PODS allow for the calculation of weighting factors to account for the influence of age. Inclusion of this feature of the two scoring methods depends on whether the researcher wishes to calculate overall survival probabilities or whether he/she needs to account for age as an independent factor.

3.2. Reliability and Validity

Even though outcome is not a criterion in assigning injury codes from the AIS, one would expect values of AIS/ISS to correlate highly with other indicators of severity. Studies indicate that the ISS correlates highly with

mortality (Baker *et al.*, 1974; Bull, 1975), time of death, hospital treatment time, and disability (Bull, 1975). In addition, the ISS correlates very well with biochemical changes (considered to be more sensitive measures of severity) such as plasma cortisol concentrations (Stoner *et al.*, 1977), blood lactate, pyruvate, alanine, and ketone bodies (Oppenheim *et al.*, 1980).

Thus, the AIS/ISS system appears to be a valid measure of injury severity. Questions have been raised, however, concerning the use of the AIS/ISS as a measure of injury severity for the subgroup of penetrating wounds such as those caused by gunshots and stabbings (Baker *et al.*, 1974; Beverland and Rutherford, 1983; Charters and Bailey, 1979; Gorman and Coals, 1983; Mackenzie *et al.*, 1981; Stoner *et al.*, 1977). Since over three-fourths of homicides and approximately 10% of assaults are committed with either knives or firearms (Fisher, 1976; Munford *et al.*, 1976; USDJ, 1983; Wright *et al.*, 1983), this raises questions concerning the applicability of the ISS to this area of criminological investigation. The problem concerns the fact that many penetrating injuries caused by firearms and knives result in several localized severe injuries. To overcome this, some researchers have suggested a lessening of the "one injury per body area" rule of the ISS (Bull, 1975; Somers, 1981, 1983), while other research indicates a need to consider penetrating wounds to the heart, great vessels, and liver as a distinct body region for ISS injury coding purposes (Beverland and Rutherford, 1983). This is an area ripe for investigation by criminologists.

There have been relatively few published assessments of the reliability of the AIS/ISS system. However, published studies indicate that using a single-page checklist reduces coder bias and increases productivity (Barancik and Chatterjee, 1981) and that using the whole medical record, rather than just the emergency-room encounter sheet, enhances reliability (Mackenzie *et al.*, 1981). Also, research indicates that a coder with training in abstracting and medical terminology can code injury severity accurately and reliably (Mackenzie *et al.*, 1981).

3.3. Utility of the AIS/ISS system

The central characteristics of the AIS/ISS injury scoring system are (1) its ability to describe injuries accurately and (2) its ability to assess injury severity validly. As mentioned above, two of the beneficial features of the system are its ability to assess multiple injuries and the reliability of the instrument(s) when used by nonphysician coders. It should be kept in mind, however, that the AIS/ISS system is not a clinical assessment technique, although anatomically precise injury descriptions are needed to assign AIS values. It was not designed as a triage or trauma management tool or to define the parameters of appropriate medical treatment. It might be

argued that a clinical assessment of injury severity would be a substantial improvement over the AIS/ISS severity scales. However, the difficulty in using many clinical assessment tools is they are subject to the influence of factors independent of the injury per se). In the earlier example of the two individuals who received identical traumatic injuries, the patient receiving the delayed medical treatment might well be deemed more severely injured. Of course, he or she would be more severely injured from a clinical perspective because of the increased threat to his or her survival. However, the diminished prospects of survival for this patient would not be due entirely to the initial injury but to the delay in receiving medical intervention. In this instance, time (delays in initiating emergency response, response time, transport time) is a critical factor which may affect survival, independent of injury. Thus, both time and injury must be measured independently. Most clinical assessments of injury severity are affected by the factor of time. The AIS/ISS scoring system is not. It is this key feature of the AIS/ISS system which has led to use in assessing the quality of hospital care for major trauma (Moylan *et al.*, 1976), as well as for determining the effectiveness of a hospital-based accident flying squad (Gorman and Coals, 1983).

3.4. Sources of Data for the AIS/ISS System

One of the unfortunate requirements of the AIS/ISS system, at least for criminologists, is accurate descriptions of injuries. At present, the three most common sources of information about crime used by criminologists—police offense reports, the UCR, and the National Crime Surveys—do not provide the information needed to assign AIS codes. That is not to say they do not provide useful information about injuries (in terms of the mechanisms of injury, as well as the spatial and temporal characteristics of injuries). Yet they do not permit the assessment of injury severity by any of the acceptable methods, either clinical (physiological) or nonclinical (anatomical).

The only criminal-justice source of acceptable injury data is found in medical examiner reports. However, while the medical examiner report is useful for determining specific injuries and thus for assigning a severity code from the Abbreviated Injury Scale, it is inadequate as an independent determinant of injury severity. This report is based on the cause of death and death is an outcome of injury. The AIS is assigned independent of the outcome of the injury. In addition, medical examiner reports provide injury information for homicide victims only.

The best source of information for scoring injuries is the hospital patient medical record. For many types of criminological research this is clearly an inappropriate source. In many situations researchers would prefer to

use existing large-scale data sets such as Vital Statistics which employ the International Classification of Diseases (ICD) for mortality. These codes provide information concerning the nature and bodily location of injuries, as well as information about the circumstances of the injuries. However, at present the ICD codes do not differentiate injury severity, nor have they been successfully linked to existing injury severity indices such as the AIS/ISS (Baker, 1982). Hence, for those wishing to address research questions in which injury is a central component, the hospital record is probably a necessary source.

4. POTENTIAL APPLICATIONS IN CRIMINOLOGY

Since the information needed to implement the AIS/ISS injury scoring system is not readily available to researchers from the more traditional criminal-justice data sources, its application in criminological research should and probably will be limited to questions in which injury constitutes a significant control or dependent variable.

As a method of assessing injury severity, the AIS/ISS scoring system may prove useful in several areas of criminological research. Some examples of its application are presented below. First, though, it should be kept in mind that the AIS/ISS permits, in addition to the assignment of an ordinal injury severity value, the classification of injuries according to both anatomical location and type of lesion. Since little is known of the injury characteristics of violent crime victims, even the limited use of the AIS/ISS system will shed light on such injuries. In addition, though, the vast majority of homicides and many assaults are accomplished with firearms and knives; the mechanisms of these two injuries can vary widely to include a variety of blunt instruments and even bodily force. In examining injuries, criminologists have been forced to focus on a single mechanism of injury (such as firearm injury) or to examine various injury mechanisms separately (i.e., firearms versus knives). Also, although an apparent majority of fatal firearm attacks is single-wound shootings (Zimring, 1972), many assault and homicide victims are the recipients of multiple injuries. Many criminologists have assumed that the number of wounds inflicted is linearly related to injury severity, an assumption of questionable merit. The AIS/ISS system provides a way of measuring these injuries regardless of the mechanism of injury or the number of injuries inflicted.

Perhaps the system is most applicable to the examination of those factors, independent of severity per se, that affect the outcome of assaultive injury. The most obvious factor is emergency medical intervention. Speculations about the possible relationship between medicine and the lethality of criminal assault began with and have continued since Wolfgang's (1958)

study of homicide (Fisher, 1976; Hawkins, 1983; Pittman and Handy, 1964; Pokorny, 1965; Rose, 1979; Vinson, 1974; Wilson, 1975), although few efforts have been made to examine it. The most attention has been given to aggregate measures of medical-care quality and homicide rates. Gastil (1971), Loftin and Hill (1974), and Doerner (1983) examined the impact of medical resources upon regional variations in homicide rates, although their efforts harvested little in terms of causal explanation. The probable reason for this low yield is that we know little about the parameters of this relationship. In Doerner's (1983) ecological study of the impact of medical resources upon lethality, he concluded with a recognition of the need for individual-level data and a method for distinguishing life-threatening injuries. In his study of the impact of ambulance response time on the lethality of criminal assault, Barlow (1983) outlines the complexity of this relationship when he concludes that response time and lethality are not related in a simple linear fashion. Hence, if the focus is on examining those factors affecting the lethality of potentially deadly injuries, the AIS/ISS system may prove to be a valuable methodological tool.

Criminological research has repeatedly indicated that homicide and aggravated assault are found most often among lower-socioeconomic status (SES) groups. Hawkins (1983) suggests, however, that receipt of emergency medical services, like medical care in general, may be significantly influenced by patterns of SES and racial stratification. Hence, members of lower-SES groups may experience higher rates of homicide independent of injury severity, partly due to interrupted, incomplete, or inadequate emergency medical intervention. Woolhandler *et al.* (1985) provide partial support for this in a study of racial differences in preventable deaths. These researchers found significant differences in the ratio of black/white preventable death rates for all causes and indicated notable excesses in preventable deaths for black homicide victims.

Another factor which may contribute to the outcome of assaultive injury independent of its severity is the presence of third parties during the event. Barlow (1983) suggested that the presence of witnesses to violent assault may serve to expedite the call for assistance for very severely injured victims. However, Luckenbill (1977) found that in only 35% of the cases he examined did the third party move to apprehend the offender, lend assistance to the victim, or notify authorities; in 17% of the cases, third parties were neutral, and in over 45% of the cases they actively supported the offender. Along these same lines, the presence of third parties may serve to lessen the extent of injuries inflicted and in some instances to facilitate the infliction of more severe injuries. Felson *et al.* (1984) found that witnesses were more likely to be supportive of violence than to serve as mediators, although when they did attempt to mediate it tended to reduce

the physical aggression of the offender(s). In order to understand better the impact of third-party actions, researchers need an accurate assessment of the severity of the injuries inflicted to assault victims.

As previously mentioned, evidence exists to suggest that the relationship between the victim and the offender may influence the severity of the injury inflicted. Victimization surveys indicate that if the offender is known to the victim, there is an increased likelihood of severe injury and an increased need for medical attention. However, as also mentioned, the measures of injury severity used to produce this finding have serious limitations. In addition, less than one-half of assaults are committed by someone known to the victim, while over one-half of the homicides are committed by someone known to the victim (although the latter phenomenon may be substantially accounted for by the fact that for over 30% of the cases in official homicide data, the victim–offender relationship is unknown). Despite the methodological shortcomings noted, this information suggests that, when the victim and offender know each other, either more serious injuries are inflicted or the receipt of emergency medical intervention is somehow disrupted.

The AIS/ISS scoring system would be useful as a measure of injury severity in studies of criminal victimization. Fattah (1981) has argued that few efforts have been made to examine the victimization process and its outcome. One area, repeat victimization, has received only scant attention. Aromaa (1973) concluded that this type of victimization is found among a very small proportion of violent crime victims. Also, recent research indicates that victim reactions to potentially violent confrontations may influence both the nature and the extent of injury (Block, 1977; Fattah, 1984, Hindelang *et al.*, 1978; Skogan and Block, 1983). However, these data do not permit an assessment of the relationship between victim behavior and the degree of injuries sustained. In order to appreciate more fully the victimization process and to examine the likely changing patterns of violent injury among repeat victims, we must utilize a more sensitive measure of injury severity such as the AIS/ISS system.

Also, the AIS/ISS system may prove useful in examining the careers of violent offenders. Typically, research into the careers of offenders concentrates on those factors which dispose offenders to illegal action (Lab, 1984). Relatively little attention is given to changing patterns of activity. Although the vast majority of offenders is involved in minor offenses and usually foregoes continued involvement in criminal behavior, evidence points to the existence of a small proportion of offenders involved in persistent criminally violent patterns of activity. At present, changes in the patterns of violent behavior, specifically the infliction of assaultive injury, are unknown. The AIS/ISS system could shed light on the possible existence of escalating seriousness in the infliction of injuries by such offenders.

Finally, the AIS/ISS system may even prove useful for research into the administration of criminal justice. Historically, the degree of harm suffered by victims of crime has weighed heavily in the assessment of punishment for offenders (Schulhofer, 1974). Although modern penal law also places a premium on the intent of the offender, the ability to grade the actual severity of injuries received by victims may partially serve to determine the equity of various penalties administered to violent offenders. In addition, this sytem may be of benefit to the administration of victim compensation. The psychological and economic response by assault victims to their victimization varies widely. This is apparently true even with regard to medical costs for assault victims. The AIS/ISS system may be of assistance in partially determining appropriate levels of compensation to victims of violent crime.

5. SUMMARY AND CONCLUSIONS

Determining the severity of physical injury for victims of violent assaultive crime has proven to be a difficult task. Past efforts have suffered from a lack of specificity, medical acceptability, methodological rigor, and ability to consider injuries derived from a variety of mechanisms. Much of this stems from a reliance on police and court records which either lack information on injuries or do not adhere to a standard procedure for including such information. Reliance on medical examiner reports, although acceptable for employing the AIS/ISS system, provides information only for homicide victims.

The AIS/ISS injury scoring system offers a valid, medically acceptable alternative method which allows for the grading of over 500 specific injury descriptions regardless of the injury mechanism or the number of injuries inflicted. This alternative method permits the classification and description of injuries, the assessment of factors affecting lethal outcome independent of injury severity, and the examination of factors influencing the severity of injuries, as well as providing a methodological tool for examining specific questions regarding patterns of offending and victimization. In addition, it may prove useful in certain areas of criminal-justice administration and research.

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