Quantifying Tissue Damage from Childhood Injury: The Minor Injury Severity Scale

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Received March 21, 1995: accepted August 9, 1995

Described an instrument designed to quantify the extent of tissue severity damage following a minor childhood injury event. Few tools exist to allow objective assessment of injury and those which do exist are oriented toward major injuries necessitating medical intervention. The Minor Injury Severity Scale (MISS) does not require specialized medical experience to apply. It yields a 0–7 score which indexes objective parameters such as depth and length of lesion for 22 different kinds of injuries. The data reported here suggest good coder reliability, excellent test–retest stability, and acceptable correspondence between mothers' and children's reports. Data are presented on divergent validity to show that tissue damage is related to but is not the same as injury outcomes such as pain, fear, and disability. Limitations of the scale and challenges to future research are also discussed.

KEY WORDS: injury; measurement; tissue severity damage.

Injuries cause more child fatalities than all disease-related deaths combined, with an estimated 22,000 deaths in children between the ages of 1 and 19 annually.

1We thank the mothers and children who were trained as participant event monitors for this project. Dr. Bernard Ewigman is thanked for his help with injury categorization and sharing his medical expertise. We thank the interviewers, Jamie Bartlestone, Ellen Glover, Paul Goddard, Deirdra Kanakis, Lisa Teegarden, and Michelle Zink for their dedication. In addition, we thank Tyeece Little and Brenda Schick for their assistance with data handling. Michelle Beabout, Sherie Cain, Steve Deimeke, Karen Lieberwitz, Vicki Riney, and Heather Washburn, are thanked for their help with coding. This project was supported by the National Institute of Child Health and Human Development Grant R01 HD25414.

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An additional 600,000 children are hospitalized each year, with almost 16 million requiring emergency medical treatment, and 30,000 children suffering permanent disabilities (Rodriguez, 1990). Furthermore, childhood injuries have devastating financial costs. For instance, childhood injuries amounted to at least $7.5 billion in direct and indirect costs in 1982, and these injuries are estimated to account for at least 1 million years of productive life lost (Guyer & Ellers, 1990). The majority of research on children's injury has focused on epidemiology, and has yielded a rich background for understanding seasonal, geographical, familial, developmental, and child-based risk factors (Rivara & Mueller, 1987). However, these risk factors do not yield specific information about the behavioral mechanisms that underlie risk for injury (Scheidt, 1988) and there is some consensus that the past research literature is insufficient to effectively inform injury prevention efforts (Butler & Mitrovich, 1987).

The study of the behavioral mechanisms of injury requires the ability to observe and quantify relevant parameters of injury. This is a challenging task. Despite the status of injury as the leading killer of children in industrialized populations, the base rate of major injury on a population-wide level is very low. In addition, injuries are highly reactive, in that they are unlikely to occur when the child is being observed. Furthermore, if injuries were entirely predictable, it would be ethically unfeasible to observe rather than prevent them. Research has thus typically focused on past events. Even then, the emotional devastation, as well as the presence of legal and moral side effects, makes obtaining accurate data following major injury very difficult (Christoffel, 1990).

We have recently argued that the study of minor injuries may be a useful adjunct to the focus on major injuries (Peterson & Brown, 1994). Minor injuries are of much higher base rate, and are less likely to be accompanied by strong emotional reactions or by legal suits and attributions of fault. To the extent that the stimuli which accompany minor injuries represent those for more major events, minor injuries may serve as a useful proxy for more serious injuries. In addition to their role as a potential indicator of major injuries, minor injuries deserve study in their own right. Minor injuries are one of the most pervasive stressful events that children encounter. As such, it seems important and useful to study such events in order to understand how children and their caregivers deal with sudden physical insult, as well as how they may respond to prevent future episodes.

The study of minor childhood injuries requires consideration of several parameters, including incidence, severity, cost to society, and intervention availability (Rodriguez, 1990). Severity is a particularly crucial factor, in that it largely determines the physical and emotional consequences for the child (Division of Injury Control, 1990). To accurately conceptualize the variables affecting minor injury, an objective, specific scale that can sensitively index injury severi-
Minor Injury Severity

It seems essential. Such a measure would create a standardized classification of minor injury severity. Such an injury severity scale would facilitate further research on both the incidence of injuries of varying severities, and the potential for some prevention methods to reduce injury severity, if not to directly prevent injury.

Unfortunately, no scale quantifying minor injury severity is currently available. Various measures of injury severity exist, but none of them are sensitive to minor types of injury. The most common and widely known index of injury severity is the Abbreviated Injury Scale (AIS: Petrucelli, 1981), which provides a single numerical rating (ranging from 0 to 6) of anatomic injury (Baker, O'Neill, Haddon, & Long, 1974; Copes et al., 1988). The AIS, however, indexes only the most serious forms of injury and is thus of little help in accurately classifying gradations of minor injury severity. In fact, the hundreds of minor injuries described later in this paper, from paper cuts to broken arms, would all be rated 0 or 1 on the AIS. In addition, the AIS was devised for use by medical personnel, using information from hospital discharge forms for accurate classification (Evans & Sheps, 1987; Petrucelli, 1981), rendering it inappropriate for home, day care, or school uses.

Although the Comprehensive Research Injury Scale (CRIS; Committee on Medical Aspects of Automotive Safety, 1972) and the Injury Severity Score (ISS; Baker et al., 1974) have been conceptualized as improved variations of the AIS, their range of severity rankings is similarly restricted to more serious injuries. Other scales have a more specific range of assessment, though the nature of the classified injuries is also quite severe. Examples are the Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) and a burn severity grading system developed by Fisher, Wells, Fulwider, and Edgerton (1977), based on the prior work of McCoy, Micks, and Lynch (1968). Similar to the AIS, CRIS, and ISS, the lowest severity rankings of these measures still constitute significant physical damage. Furthermore, most of these scales employ vague, subjective classification criteria that allow for differing interpretations of the extent of injury severity (Barancik & Chatterjee, 1981; Donders, 1992; Perry, Buffler, & Sanderson, 1982).

Few scales exist that are sensitive to the more minor types of injuries, and unfortunately, those that are available are limited by subjective and ambiguous categorization. For instance, Seaberg (1977) discussed a scale for assessing injury severity of child abuse injuries. To use this scale appropriately, coders viewed each interval as equal, but no other specific criteria were given to accurately differentiate between degrees of severity. Thus, overall severity rankings and distinctions between minor and major injuries are somewhat arbitrary.

In a discussion of measuring injury severity of school injuries, Evans and Sheps (1987) emphasized the lack of categorical agreement concerning the dimension and degree of severity being measured. The studies that they compared only defined minor injuries as an absence of a specified major injury (Boyce,
Sprunger, Sobolewski, & Schaefer, 1984; Feldman et al., 1983) and they found significant discrepancies between studies regarding the classifications of similar injuries, due to the vague criteria used.

It appears, then, that there is a noticeable lack of adequate instruments available to index the severity of minor injuries. Severity measures that are currently used are targeted towards more severe injuries and typically must be employed by medical professionals (Evans & Sheps, 1987). The few existing scales that are more sensitive to minor injury are limited by vague classification that is vulnerable to a great deal of personal interpretation, and may not be relevant to many forms of unintentional injury.

This paper presents the Minor Injury Severity Scale (MISS), a tool that successfully addresses many of the limitations inherent in the available selection of relevant measures. The MISS is meant to be used by lay persons with no previous medical training to classify written descriptions of minor injuries. Indeed, this ranking system can be effectively mastered by parents, teachers, and so forth, in only a few hours. Though designed specifically for minor injuries, this measure is capable of classifying major injuries (including permanent disability or death). However, in contrast to most existing injury severity scales, its sensitivity falls within the less severe spectrum of injuries.

Furthermore, the MISS consists of highly specific, descriptive, and quantifiable categories, which facilitate accurate and objective classification. As discussed in greater detail in Methods, this ranking system was constructed to reflect tissue damage as an outcome and is therefore sensitive to the differential effects of injuries of similar size and depth that damage different body parts (e.g., a burn on the face is given a higher severity ranking than a burn of the same size on the back, because the outcome of a facial burn is more serious for the child). In addition, the MISS accounts for the appreciable effect of multiple minor injuries in determining the overall severity ranking of the injury occurrence. It should be noted that the MISS focuses only on tissue damage; variables such as pain, disability, and fear are additional outcomes of an injury event which are likely to be related to severity of tissue damage, but which are regarded as separate variables. The remainder of this paper describes more specifically the construction, format, and psychometric properties of the MISS.

METHOD

Participants

Second-grade children and their mothers were selected randomly from a list of all second graders in the local school district, with the intention of recruiting 66 families. Second graders were chosen because our task demanded that the children be old enough to fill out longhand reports. Mothers received a letter
describing the nature of the study and were then called to determine agreement to participate.

Given the desire to record commonly occurring injuries, the individuals who were chosen at random were screened to produce a fairly homogeneous sample. Thus, children were eliminated if they had been diagnosed with mental retardation, a learning disability, a behavioral disorder, a physical disability (other than requiring eye glasses), or if there was a history of an overnight hospitalization due to injury in the family during the last 5 years. Furthermore, to increase the probability that participants would remain in contact for the duration of the study, families were eliminated if they had moved recently, intended to move, or if the child was in residence less than 12 out of every 14 days. To insure that full communication was possible, the mother and child were both required to speak English.

Of those second graders that were eligible, 63% agreed to participate in the study (33 girls and 33 boys). The final sample of mothers and children who completed all 22 interviews included 30 girls and 31 boys (age 8 years 3 months to 9 years). All mothers and children completed written consent forms at the beginning of the study and each mother–child dyad received $1 per day of participation.

Demographically, the sample represented the local population with slightly fewer ethnic minorities. The local census revealed that 93% of the population was white and 7% was minority. Our sample was 97% white and 3% minority. There was a wide range of socioeconomic status with a slight majority of participants being middle-class. Hollingshead and Redlich’s (1958) two-factor index indicated that 8% of the families were Class I, 50% were Class II, 22% were Class III, 17% were Class IV, and 3% were Class V. Using Duncan’s revised socioeconomic index (Hauser & Featherman, 1977) the range was between 7.1 and 92.1, with a mean of 54.8.

**Interviewers**

Six graduate-level assistants (1 male and 5 female) who were unfamiliar with the hypothesis or the injury prevention literature were employed as interviewers. Each interviewer was assigned a single group of 10 or 11 families to interview throughout the duration of the study. Several weeks of training were provided to insure that interviewers administered open-ended, nonleading interviews about everyday injury events.

**Coders**

Six undergraduate coders read the descriptions of each of the injuries as reported separately by both mothers and children. They then coded each report on a scale of 0 to 7 using the MISS (described below). In addition, one trained
individual coded all of the test–retest reliability data. All of the coders were uninformed of any experimental hypotheses. Test–retest reliabilities were performed on the same injuries reported on two separate occasions by mothers and children. The coder was unaware of which reports matched and coded all of the records individually.

**Minor Injury Severity Scale (MISS)**

*Creation of Measure*

The goal of creating the MISS was to develop a measure that was sensitive to minor injuries and was applicable to a wide range of settings. (Copies of the MISS can be obtained from the first author.) The scale had interval ratings from 0 (no injury) to 7 (death), coding the amount of tissue damage that occurred as the result of a given injury. Tissue damage was determined by eliciting objective observational data during the interviews, including reports on the amount of swelling, depth of laceration, resulting discoloration, amount of tenderness, amount of blood loss, and level of blistering. The amount of swelling was measured using the "bumpometer," a visual scale that approximated gradients of "raisedness," on a scale of 0 to 9. Depth and width were measured using standard rulers.

Due to the vast difference in the body’s physical reactions to tissue damage depending on where on the body and the type of injury that occurs, 22 separate categories were developed for different types of injuries (see Peterson, Bar- telstone, Kern, & Gillies, 1995). Within these categories, the codes were described specifically for the type of injury (e.g., cuts, which involved depth and the bifurcation of cells, were rated on a different scale than scrapes, which involved the sandpapering off of cells). No attempt was made to make codes exactly equal across categories. This lack of precise equivalence was due to the types of observations made in the coding. That is, the amount of swelling that may occur due to a scrape on the face cannot be compared to the amount of swelling that would occur with a bruise on the knee. If one were to code both of these injuries based on the amount of swelling alone, then the facial injury would be coded much higher than the knee, even though the severity of the tissue damage itself may not be any different. Thus, the degree of swelling (or other parameter) to yield a rating of 3 for one category was not the same as that yielding a rating of 3 for another.

*Scale Development*

Development of the MISS was an iterative process. Using approximately 100 minor injuries gathered from the participant event monitoring (described
below), the initial scale was applied. As they were classifying injuries, coders discussed ways in which the scale could be improved to better categorize injuries. The scale was continuously reformatted and injuries recategorized. This process continued throughout the initial coding of over 200 injury events. Upon completion of these events, all of these injuries and the subsequent events were categorized using the final revision of the MISS.

A physician consultant provided supervision over the process of scale development. He suggested ways in which some injuries may manifest for different parts of the body. In addition, he offered advice as to which types of injuries should be grouped together and which demanded a category that should stand alone.

**Final Description of MISS**

The completed scale was composed of 22 injury type categories (e.g., Animal Scratch/Bite, Bruise/Blump; see listing in Table II). Within each category, an injury could be rated between 0 and 7. If an injury showed no apparent tissue damage, it was coded as a 0 in each category. If an injury resulted in any permanent damage or disability, it was rated as a 6 in each category and if the injury resulted in death, it was rated as a 7. All other ratings differed depending on the type of injury.

To obtain adequate descriptions of injuries as necessary to use the MISS, several additional tools were used during the interview process. The bumpometer, mentioned previously, was created to help rate the degree of swelling an injury induced. Rulers were used to explicitly measure the depth and width of visual tissue damage. Specific ratings under each category refer to information obtained from each of these tools in order to maximize the operationalization of injury severity.

It is important to recognize that the MISS is positively skewed toward minor injury regardless of the injury type category. That is, the amount of tissue damage required to move up the scale from a 1 to a 2 is less than the degree of injury to move from a 5 to a 6. At higher levels of the scale, the extent of discrimination is much reduced (See Appendix.) In other words, if one were to imagine the scale linearly, the increments between numerical ratings increases as the level of severity increases. This was done deliberately to allow for extensive sensitivity at the low end of the scale. This is a measure of minor injury—few events at the high end of the scale are expected.

**Application of Measure**

Gathering injury events for categorization was a yearlong process. During the first session, mothers and children received detailed training in "participant
event monitoring” and methods of keeping recording materials accessible were discussed. During this time, they were instructed on how to define an injury (i.e., tissue damage with a specific time of onset, which left a visible mark for over an hour or which resulted in pain for over 15 minutes) and the interviewer trained them by modeling how to keep an appropriate record and giving feedback as the participants filled out a fictitious record. They were instructed to write longhand descriptions of the injury in enough detail to be able to recall the event later. They then recorded the type of injury that occurred, their emotional reaction and the other person’s (e.g., mother if the child was reporting) emotional reaction. A body chart (both front and back) was used to mark the site of the injury on the body. Immediate feedback was given if changes in reporting style were necessary. Mothers and children were asked to not discuss their records with one another.

Following the initial interview, 21 interviews were conducted separately (out of earshot) for mothers and children, every 2 weeks. Each interview lasted between 60 and 90 minutes. Using a list of minor injury types empirically derived in an earlier study (Peterson, Harbeck, & Moreno, 1993), interviewers asked participants one at a time if each type of injury had occurred over the past 2-week period. If the participant responded “yes,” the interviewer proceeded to ask for a detailed description of the events. Specifically, the interviewer asked about injury treatment, the number of doctor visits necessary, the number of school days absent due to the injury, the length of disability due to the injury, the intensity of the worst pain felt, the duration of the worst pain felt, the average level of pain across recovery from the injury, the average duration of pain, the amount of anxiety the child felt at the time of the injury, the level of the child’s fear after the injury event and the subjective feeling of the level of seriousness of the injury. Table 1 describes the responses made available to the participants in answering these variables.

In addition, interviewers asked the participants to specifically describe the amount of tissue damage resulting from the injury event. The bumpometer, a visual scale from 0 to 9, was used during the interview to indicate the level of swelling that occurred and rulers were used to indicate the depth and width of the tissue damage.

During a single 2-week period, the same procedures were repeated for all of the families by a second interviewer, the purpose being to check for test–retest reliability. Both mothers and children had an acceptable level of reliability (described in Results). Note that a single coder handled all of these data to avoid confounding test–retest and intercoder reliability.

All interviews were audiotaped and later transcribed verbatim. For the first month of interviews, the project coordinator checked all records and then continued to check 10% of all records for the remainder of the study. More information
Table I. Description of Specific Data Gathered From Both Mothers and Children When Describing Each Injury Event

<table>
<thead>
<tr>
<th>Subjective/objective measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury treatment</td>
<td>0 = no treatment or examination; 1 = adult examined only; 2 = cleansed and comforted; 3 = mild home treatment; 4 = serious home treatment (≥ 5 minutes medical consultation); 5 = visit to doctor or ER; 6 = medical treatment (e.g., stitches or cast); 7 = hospitalization</td>
</tr>
<tr>
<td>No. of doctor visits</td>
<td>No. of times seen by a doctor</td>
</tr>
<tr>
<td>School days absent</td>
<td>No. of days child missed school as a direct result of the injury event</td>
</tr>
<tr>
<td>Length of disability</td>
<td>≤ 1 minute, ≤ 5 minutes, ≤ 30 minutes, ≤ 1 hour, ≤ 6 hours, ≤ 1 day, ≤ 3 days, ≤ 1 week, &gt; 1 week</td>
</tr>
<tr>
<td>Intensity of worst pain</td>
<td>1 = very little pain to 5 = most pain child has ever felt</td>
</tr>
<tr>
<td>Length of worst pain</td>
<td>Time in minutes</td>
</tr>
<tr>
<td>Average pain across recovery</td>
<td>1 = very little pain to 5 = most pain child has ever felt</td>
</tr>
<tr>
<td>Length of average pain</td>
<td>Time in minutes</td>
</tr>
<tr>
<td>Anxiety at time of the injury</td>
<td>1 = not at all anxious to 5 = very very anxious</td>
</tr>
<tr>
<td>Fear after the injury</td>
<td>1 = not at all frightened to 5 = very very frightened</td>
</tr>
<tr>
<td>Seriousness of injury</td>
<td>1 = not at all serious to 5 = very very serious</td>
</tr>
</tbody>
</table>

was required on less than 5% of the data. Upon completion of the study, coders read each description of the injuries and rated them using the MISS.

RESULTS

This section summarizes data relevant to the construction and use of the MISS. First, we consider the psychometric properties of the scale, including coder reliability, test–retest reliability, and the correspondence between mothers and children for those injuries that were reported by both. Next, the patterns of severity (type of injury, mean, standard deviation, and range) seen on a sample of over 1,000 minor injuries are described to illustrate the likely utility of the scale. Finally, the relationships between the MISS (which is an index of tissue damage) and other outcomes of injury events, including perceived need for intervention, disability, pain, anxiety, and fear, are considered.

Past analyses of injury reports by these same mothers and children revealed no differences due to gender (Peterson et al., 1995). Thus, boys’ and girls’ data have been collapsed in the analyses presented here. In addition, patterns of injuries reported by mothers and children were very similar and thus, our second section here presents only the mothers’ data. However, the relationship between outcome variables might be expected to differ for mothers’ and children’s reports, as many of the outcome are subjective experiences such as pain and
anxiety. Thus, mothers' and children's data are presented separately for the relationships between the MISS and other outcome variables.

**Psychometric Properties**

**Coder Reliability.** As described earlier, six trained coders individually read the descriptions of each of the injuries and rated them on a scale of 0 to 7 using the MISS. To afford a measure of reliability for coding, these uninformed raters overlapped on approximately 20% of the data. The intercoder reliability of the MISS ratings was acceptable (Pearson r = .71).

**Test-retest Reliability.** Mothers and children were interviewed twice over the same 2-week period. A single trained individual coded all of the test-retest reliability data. She was unaware of which records matched and completed ratings of the longhand descriptions of the injuries independent of one another. Test-retest reliabilities were calculated on all injuries for this 2-week period and were excellent for both mothers (r = .99) and children (r = .98).

**Mother-child Correspondence.** For those injuries reported by both the mother and the child, there was a moderate agreement on the individually reported dimensions of the severity of injury (interclass correlation r = .53). Note that the upper limit of the correlation that could be obtained was determined by the coder reliability of .71.

**Patterns of Injury Severity**

As described earlier, the MISS scores were categorized based on injuries that occur commonly. If no tissue damage was perceived (rating of 0), the injury was recorded as a near injury and was not included in the analyses. Table II lists the frequencies and mean severity of each type of injury as rated on the MISS. Again, the scale does not provide exact comparability across categories for each rating, for example, a 3 rating given to a bruise/bump should not be equated as exactly the same degree of tissue damage as a 3 rating given to an eye injury, although both are represented as intermediate on a scale ranging from 0 (no injury) or 1 (trivial injury) to 6 (severe damage resulting in disability) or 7 (death).

As seen in Table II, the majority of injuries were given a code of 4 or below and thus, the MISS tended to describe more minor injuries than injuries which

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3 Despite the very objective nature of the MISS, the reports varied in terms of the clarity with which the dimensions of the injury were reported. On some injuries, not all dimensions (depth, width, discoloration, swelling, bleeding) were reported. Sometimes there were disparities in the dimensions that were reported (e.g., a child would insist that a 2-mm cut bled ¼ cup of blood). Coders were trained to consider the more objective aspect (e.g., shape, size) over aspects that might be more subjective (e.g., blood loss). However, application of the MISS to data obtained from mothers and children does require the use of subjective judgments, thus accounting for the acceptable but not high reliability among coders.
Table II. Descriptive Statistics of Injuries Coded on the Injury Severity Rating Scale

<table>
<thead>
<tr>
<th>Injury category</th>
<th>Frequency</th>
<th>M</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal scratch/bite</td>
<td>46</td>
<td>1.780</td>
<td>0.629</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Bruise/bump</td>
<td>278</td>
<td>1.690</td>
<td>0.752</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Burn</td>
<td>34</td>
<td>2.618</td>
<td>0.739</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Choke/drown</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Crushing injuries</td>
<td>34</td>
<td>1.588</td>
<td>0.743</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Cut</td>
<td>123</td>
<td>2.024</td>
<td>0.844</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Electricity</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eye</td>
<td>15</td>
<td>1.600</td>
<td>0.828</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Firearm/bow</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor/rug burn</td>
<td>22</td>
<td>1.909</td>
<td>0.684</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>10</td>
<td>1.600</td>
<td>0.516</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Joint/bone/muscle</td>
<td>73</td>
<td>1.534</td>
<td>0.817</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>1</td>
<td>3.000</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Nosebleeds</td>
<td>3</td>
<td>1.333</td>
<td>0.577</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Paper cut</td>
<td>3</td>
<td>1.000</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Poison</td>
<td>2</td>
<td>2.500</td>
<td>0.707</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Puncture/splinter</td>
<td>41</td>
<td>1.829</td>
<td>0.587</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Scrape</td>
<td>316</td>
<td>1.756</td>
<td>0.586</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Stings</td>
<td>9</td>
<td>2.111</td>
<td>0.601</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Testicle impact</td>
<td>2</td>
<td>2.000</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Tooth injuries</td>
<td>6</td>
<td>2.167</td>
<td>1.169</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Torn finger/toenails</td>
<td>4</td>
<td>1.500</td>
<td>0.577</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

were more severe. On the other hand, the scale does register the concussion (Bruise/bump = 5) and broken arm (Joint/bone/muscle = 5) which emerged from this yearlong study of 61 children's injuries.

Note that some of the categories that were empirically derived (by occurrence of an event that could not be well classified elsewhere) resulted in no tissue damage being sustained and thus zeros appear for the mean and range. Such injuries logically are made up of events for which the tissue damage, if sustained, would be likely to be very serious (e.g., Choke/drown, Electricity, and Firearm/bow). The large proportion of injuries were classified within four of the 22 types shown in Table II. The high base rate categories were Scrapes (n = 316), Bruise/bump (n = 278), Cut (n = 123), and issues involving Joint/bone/muscle tissue (n = 73). The standard deviations for these injuries were typically less than 1 but more than 0.50, suggesting an appropriate level of sensitivity to the measurement of minor injuries.

Relationship to Other Injury Event Outcomes

Injury severity scores derived from the mothers' and children's detailed descriptions of the tissue damage resulting from an injury event (length and depth...
of lesion, discoloration, swelling, etc.) were correlated with several other injury outcome variables. Specifically, we examined the relationship between the MISS score and injury treatment (including ice or bandages), the number of physician visits, the number of school days absent due to injury, length of disability (inability to complete normal life tasks such as writing, walking, dressing, etc.), intensity of worst pain, average pain across recovery, average length of pain, anxiety at the time of injury, fear after, and respondent's subjective rating from 1(low) to 5(high) of overall "Seriousness" of the injury (a global subjective rating), for both mothers and children.

As can be seen in Table III, there was a significant correlation for the level of tissue damage indexed by the MISS with each of the subjective and objective reports, with the exception of School Days Absent, for both mothers and children. The majority of these relationships remained after Bonferroni correction to \( p < .007 \). However, as revealed by the actual Pearson coefficients, the correlations were only moderate (\( r = .10 \) to .24), suggesting divergent validity. Thus, although degree of tissue damage is related to variables such as treatment, disability, and pain, these data suggest that it is not the same variable as these other outcomes.

In contrast, examine the relationships between a typical index of injury severity, the global subjective Seriousness scale and the outcome variables (see Table III). In most cases (and particularly for the more subjective variables such as length of time of disability, and affective reactions such as pain, anxiety and fear) there were much stronger relationships between subject-rated Seriousness and other outcomes, suggesting the participants' tendencies to consider a variety of lesion, discoloration, swelling, etc.) were correlated with several other injury outcome variables. Specifically, we examined the relationship between the MISS score and injury treatment (including ice or bandages), the number of physician visits, the number of school days absent due to injury, length of disability (inability to complete normal life tasks such as writing, walking, dressing, etc.), intensity of worst pain, average pain across recovery, average length of pain, anxiety at the time of injury, fear after, and respondent's subjective rating from 1(low) to 5(high) of overall "Seriousness" of the injury (a global subjective rating), for both mothers and children.

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Table III. Correlations of Mothers' and Children's Reports of Objective and Subjective Measures with Injury as Coded on the MISS and Reporter's Belief About the Seriousness of the Injury

<table>
<thead>
<tr>
<th>Subjective/objective measure</th>
<th>Mothers' reports</th>
<th>Children's reports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MISS code</td>
<td>Report of seriousness</td>
</tr>
<tr>
<td>Injury treatment</td>
<td>0.199*</td>
<td>0.347*</td>
</tr>
<tr>
<td>No. of doctor visits</td>
<td>0.233*</td>
<td>0.263*</td>
</tr>
<tr>
<td>School days absent due to injury</td>
<td>0.064*</td>
<td>0.023</td>
</tr>
<tr>
<td>Length of disability due to injury</td>
<td>0.103*</td>
<td>0.267*</td>
</tr>
<tr>
<td>Intensity of worst pain</td>
<td>0.181*</td>
<td>0.509*</td>
</tr>
<tr>
<td>Length of worst pain</td>
<td>0.143*</td>
<td>0.217*</td>
</tr>
<tr>
<td>Average pain across recovery</td>
<td>0.155*</td>
<td>0.465*</td>
</tr>
<tr>
<td>Average length of pain</td>
<td>0.152*</td>
<td>0.365*</td>
</tr>
<tr>
<td>Anxiety at time of injury</td>
<td>0.197*</td>
<td>0.442*</td>
</tr>
<tr>
<td>Fear after injury</td>
<td>0.184*</td>
<td>0.477*</td>
</tr>
</tbody>
</table>

\( ^* p < .05. \)
\( ^{**} p < .001. \)
of factors in addition to actual tissue damage (pain and fear being prominent candidates) when evaluating Seriousness. In other words, if a subjective measure such as seriousness of the injury is used, the integrity of the variable as a measure of tissue damage sustained is likely to be compromised by the addition of other related (but not the same) factors. Similarly, the participants’ ratings of Seriousness and the coders’ rankings of the same injuries for degree of tissue damage were significantly related, $r = .24, p < .001$, albeit at only a moderate level.

DISCUSSION

Psychometric Properties

Examination of the psychometric findings on the MISS suggests that descriptive data reported through participant event monitoring by laypersons (the mothers and children) can be accurately quantified by undergraduate coders who have no specialized medical training. These data show excellent test–retest stability. Correspondence between mothers’ and children’s reports made within 2 weeks of the injury was lower, but came close ($r = .53$) to the lower range of acceptable interobserver reliability ($r = .60$) suggested in the literature (e.g., Hartmann, 1977). Given that such correspondence involved interviewer, reporter, and coder differences, a delay of up to 2 weeks between reports, and (to avoid reactivity) children and parents never received feedback about discrepancies, this degree of agreement was deemed acceptable. If individuals such as school nurses or day-care personnel could be trained with the MISS so that the same individual both recorded and scaled the relevant information immediately, stronger correspondence between informants might be expected. This type of use of the MISS awaits further research.

Application

The MISS was sufficiently comprehensive to quantify all of the collected injuries. The average ratings for most of the injury types documented the importance of having sensitivity at the lower end of the scales, with the large majority of injuries coded as 4 or below and average ratings all under 3. The majority of the scales showed some range (from 1 to 3, 4, or 5) and standard deviations of less than 1 scale point, suggesting that within an injury type, the majority of injuries tend to be homogenous with respect to the amount of tissue damage sustained.

The use of 22 different codes allowed for a very clear specification of the type and dimensions of a given injury. In contrast to the most commonly used
measure of injury severity, the AIS, which provides only the broadest descriptions of an injury (e.g., 1 = minor lacerations, 2 = disfiguring lacerations), the MISS clearly specifies the various parameters of injury (e.g., a laceration) including placement on the body, depth of the lesion to the \( \frac{1}{6} \)th of an inch and length to the \( \frac{1}{8} \)th of an inch. This allows clear standardized communication about the nature of an injury, facilitates record keeping, and allows discriminating quantification of the outcome of minor injury.

**Discriminant Validity**

The present data demonstrate that, for minor injuries, outcome data such as pain, disability, and fear bear significant but only moderate relationships to the actual tissue damage sustained. These findings suggest the importance of maintaining a separate measure of tissue damage severity. Such a measure is less likely than some previously used strategies to be subject to artifactual conclusions due to individual differences. For example, if the amount of intervention necessitated by an injury is used as the method of quantifying severity (as in home treatment–minor, home treatment–major, medical advice, medical treatment in clinic, etc.), caregivers who are especially concerned and prone to intervene will be found to have children with more "serious" injuries. Similarly, if the child’s responses to the injury in terms of pain or disability are used as an index of severity, more temperamentally anxious or demonstrative children will be found to have more "serious" injuries. Only a scale that objectively describes the extent and type of tissue damage itself will be free of such artifactual conclusions.

One could argue that a blow of the same strength will cause a different outcome (e.g., more bleeding or swelling) in one child than another, and to this extent the scale will not yield the same score for two children experiencing the same event. It is possible that this is because the two children actually obtain differing amounts of tissue damage. Regardless, differences that yield differing degrees of bleeding or swelling are unlikely to produce the kind of misleading, systematic findings that psychosocial variables such as an over concerned caregiver or a highly expressive child might create with more subjective measures.

**Limitations**

The MISS is anticipated to be relevant to minor injuries sustained by individuals of all developmental levels. However, the current sample explored only injuries in 8-year-old children. Furthermore, the majority of these children were Caucasian and middle class, living in a relatively small Midwestern community.
Future research is needed to document the application of the scales to children of different ages and ethnicities, and children living in environments that may pose different kinds of hazards.

In addition, the injuries described by this study quantified by the MISS were typical of minor injuries sustained by elementary age children. The upper limits of this scale were not put to the test as they might be if the scale was to be used in a setting likely to produce higher levels of injury (such as children's athletics). The utility of this scale for such settings remains to be determined, as the scale was devised to discriminate between relatively minor injuries.

**Future Research**

There are a variety of potential uses for the MISS. The simplest application is the description of patterns of injury in various locations, at differing times, and following differing activities and levels of supervision. A harm reduction approach to injuries suggests that when injuries cannot be avoided entirely, diminishing their severity is an important outcome. Thus, identifying environmental and psychosocial factors associated not only with diminished frequency but also with diminished severity of injury seems an important goal. The extent to which the MISS can assist in achieving this goal remains to future research.

The MISS might also be used as a pre–post measure for interventions designed to prevent injuries. In addition to avoiding injury vectors entirely, some methods of prevention rely on altering the extent of contact with the vector (e.g., teaching in-line skaters to relax and roll into a fall, as well as to wear a helmet and pads) and the outcome of such training might be examined with the MISS.

Finally, the extent to which the MISS can be applied cost effectively (with minimal training and rating time) to relevant settings such as day-care centers, school play yards, summer camps, and other locations of heightened probability of injury remains to be determined.

**Conclusion**

This article began with strong statements concerning the serious threat of children's injuries, the utility and importance of studying minor injuries, and the dearth of tools currently available to make such study possible. The data reported here document the sound psychometric properties of the MISS, its ability to describe the large majority of common childhood injuries, and its discriminative validity. We hope that the MISS can be added to the armaments available to researchers seeking to wage war against the leading killer of children in this country—unintentional injury.
APPENDIX

As an example, consider the scale for rating of a cut (0 and 7 not included as 0 = no tissue damage and 7 = death).

Rating of cut = 1: Body—Shallow laceration; ≤ 1/16 in. (.16 cm) in either width or depth; little bleeding.
   Hand/Foot—rated > 1 unless very small [< 1/32 in. (.08 cm)].
   Joint/Face—rated > 1 unless very small [< 1/32 in. (.08 cm)].

Rating of cut = 2: Body—1/16 in. (.16 cm) < x ≤ 1/32 in. (.32 cm) in depth or width; some bleeding.
   Hand/Foot—Shallow laceration; 1/32 in. (.08 cm) < x ≤ 1/16 in. (.16 cm) in either width or depth; little bleeding.
   Joint/Face—Shallow laceration; ≤ 1/16 in. (.16 cm) in either width or depth; little bleeding.

Rating of cut = 3: Body—1/8 in. (.32 cm) < x ≤ 1/4 in. (1.27 cm) in depth or width; bleeding.
   Hand/Foot—1/16 in. (.16 cm) < x ≤ 1/8 in. (.32 cm).
   Joint/Face—1/16 in. (.16 cm) < x ≤ 1/8 in. (.32 cm).

Rating of cut = 4: Body—Deep cut into dermis, but only subcutaneous fat or insignificant muscle involvement [< 1 in. (2.54 cm) deep or wide].
   Hand/Foot—1/8 in. (.32 cm) < x ≤ 1/2 in. (1.27 cm) depth or width.
   Joint/Face—1/8 in. (.32 cm) < x ≤ 1/2 in. (1.27 cm) depth or width.

Rating of cut = 5: Body—Deep laceration involving ligaments, peripheral nerves, or substantial portion of muscle.
   Joint/Hand/Foot/Face—Deep into dermis, subcutaneous fat or muscle involved.

Rating of cut = 6: Significant laceration of vital organ or functional body part. Examples include laceration of the eye, brain, liver, spinal cord, disfiguring lacerations of the face.

REFERENCES


Minor Injury Severity


