Quantitative Minor Injury Scale: pilot study of a scale to measure level of minor injury after motor vehicle collisions

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Study objective: **Severity of physical injury after motor vehicle collisions (MVC) may associate with survivors' mental health; however the quantitative relationship is poorly understood. This is partly because existing injury scales are only sensitive in the potentially fatal range, while most MVC injuries are minor. To quantitatively describe a minor injury, a Quantitative Minor Injury Scale (QMIS) was developed based on injury symptoms, medication, imaging examination, age and hospital stay.**

Methods: **We developed the QMIS after analyzing existing injury and trauma scales coupled with input from Emergency physicians. We recruited 32 MVC survivors with minor injury (rated 1-2 on Abbreviated Injury Scale) who visited the emergency department (ED) within 48 hours of the accident. Depression symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D) within 3 weeks of the trauma and their injuries were quantified with the QMIS.**

Results: **Application of the QMIS in the MVC survivors produced a gradient from 0.6 to 7.8 with an average of 2.65. A significant correlation (R=0.366; p=0.039; n=32) was found with the QMIS score and depression symptoms as measured by the CES-D.**

Conclusions: **Results suggest the QMIS creates differentiation among a population of minor injury patients and may be useful in examining the relationship between minor injury and psychological conditions. The further development of QMIS may generalize the usage of this scale to minor injuries caused by other types of trauma.**

minor injury | injury scale | minor trauma | motor vehicle collision

Survivors of motor vehicle collisions (MVC) have reported psychiatric conditions, such as acute stress disorder (ASD), post-traumatic stress disorder (PTSD), generalized anxiety disorder, phobias, substance abuse and depression (1-4). Up to 67% of MVC victims seeking medico-legal assessment suffered from depression (1). Injured patients reported more post-MVC mental health hospitalizations and physician mental health claims than non-injured (5), indicating mental health problems may be associated with severity of injury. Numerical injury scales, the Abbreviated Injury Scale (AIS)(6) and the Injury Severity Score (ISS)(7), are standardized anatomic scoring systems developed to predict trauma patient mortality, evaluate patient outcome, conduct epidemiological research and longitudinal trauma center comparisons. Other scales incorporate physiologic functioning; Glasgow Coma Scale (GCS)(8) and Trauma and Injury Severity Score (TRISS)(9) are used to assess level of consciousness after head injury and predict patient survival after blunt or penetrating trauma respectively. Variable correlation between injury severity and mental health problems has been found using these scales (2, 10-14). The controversy may be influenced by the significant number of MVC survivors with solely minor injuries such as sprained joints and contusions.

Importance. The CDC reports nearly 3 million MVCs a year in the United States of America. Of these, 92.7% were treated in the ED and released without further hospitalization (15). Over a 6 year period, the Queensland Trauma registry reported that minor injury of any etiology, as determined by contemporary scales, accounted for nearly 90% of all recorded trauma admitted, and significantly contributed to the burden of injury (16). The impact of minor injuries on survivor's mental health is understudied largely because of an absence of a sensitive, easy to use scale to evaluate severity and distinguish demarcations among this undifferentiated category of injury. The injury severity scales that aim to categorize the severity of minor injuries may open this large survivor group to future research regarding psychiatric morbidity.

Study Goals. The purpose of this study is to establish a numerical system, Quantitative Minor Injury Scale (QMIS), to evaluate MVC patients' minor injuries, as defined by an AIS score of 1-2. The AIS is an anatomical score considering location and type of injury with a scale of one to six; 'one' being minor such as a contusion, 'three' serious including an open fracture of the humerus, and 'six' representing maximum, untreatable severity with a certain probability of death (6). Common medical procedures to assess and treat these injuries in the Emergency Department (ED) setting include imaging, pain medication, or hospitalization for observation. The injury type and medical care administered in the ED may give an objective evaluation of the severity of a particular minor injury. The proposed QMIS is used to test the relationship of injury severity and mental health in a cohort of MVC survivors having minor injuries.

Methods

Participants. The patients were recruited from the ED of The University of Toledo Medical Center and level one trauma center. Patients

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Author contributions: ABB, KRB, ADD and XW conceived the study and designed the trial. KRB, MBT and XW obtained research funding. All authors supervised conduct of the trial and data collection. ABB and XW undertook recruitment of participating patients and managed the data. MBT, JBS, HX and ADD provided analysis and advice for psychiatric studies. HX and XW provided statistical advice and assisted in data analysis. ABB drafted the manuscript and all authors contributed to its revision. KRB and ABB are equally contributed to the manuscript as a whole.

The authors declare no conflict of interest

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were excluded if their injuries were too severe (AIS 3+)(6) or they were unwilling to participate. Local institutional review committee approval was obtained and all patients gave written informed consent. All subjects experienced a non-fatal MVA and visited the ED within 48 hours of the accident. All were non-pregnant, English-speaking, alert and oriented without intracranial injury; no selection was based on race or gender. The patients were required to complete a series of surveys: during their initial ED visit, within 2-3 weeks of the accident, one month and three months after the accident.

QMIS Score Calculation. Review of patient ED medical records identified information on underlying injury, age, imaging studies performed, medication received and length of hospital stay. The QMIS was calculated for all patients deemed non-serious, with AIS less than 3 (6).

The QMIS has five additive categories leading to a thorough, objective picture of the patient's minor injury severity: type of presenting physical injury, medication utilized, imaging studies, patient age and ED disposition (admit/discharge). Based on previous injury scales and survivability ratios (6-9, 17) the QMIS was created (Table 1[Supplementary File]).

The physical injury category has different values depending on location: with a higher score if on the face. Similarly, closed fractures have higher values for different bones: a fractured tibia is more significant than a fractured phalange. If a patient presents with multiple minor injuries they are summated into one presenting injury symptom score; for example: 5+ contusions not to the face, a strained joint, and a 3-10cm facial laceration requiring sutures: (0.75+1+1.5=3.25). The patient's age was then taken into account by adding a percentage of the injury symptom score: 12.5% for patients 40-55, 25% for patients 55-70, and 50% for 70+. Similar presented injuries could impact older individuals more. A substantial number of older adults involved in MVCs with only minor injuries are at risk for persistent pain after discharge (18). If admitted, a fraction of the patient's presenting injury symptom score is added per day as the hospital stay category. For example: if the previous injury symptom score of 3.25 required admittance for one day, an additional 33% is added. Utilized medication was divided into oral (PO) non-narcotic, narcotic PO and intravenous (IV) narcotics, with a single value corresponding to the maximum tier given during the visit. Imaging studies involve increasing scores based on the type of procedure, with a maximum of 4 X-rays or 2 computed tomography scans (CT). This reflects physician's concern about a potentially more serious injury. The scores are lastly summed to reflect the severity of the minor injury. The patients were scored by research personnel with medical training.

Data Anlaysis. The Center for Epidemiologic Studies Depression Scale (CES-D) was administered within 3 weeks post-MVC to evaluate the depression symptoms after the trauma. Correlation analyses were performed in SPSS (version 17) to explore the relationship between injury severity and psychiatric symptoms. The results are reported as mean$\pm$standard deviation.

Results

Distribution. Thirty-two patients who met criteria were recruited from University of Toledo Medical Center ED in a four month period. The participants (16 males, 16 females; age range 21-65, mean 33) experienced a MVC within 48 hours before their ED visits and were rated as non-seriously injured on the AIS (6) (29 participants scored 1 and 3 participants scored 2).

The minor injuries seen in participants included: soft tissue injury, minor head injuries, lacerations, closed fractures, etc. The average QMIS presenting injury symptom score was 1.80; the highest was 5.25 from a patient with brief loss of consciousness, sutures for a facial laceration and a head contusion. Two participants had their injury symptom scores increased by 33% per day based on overnight observation in the hospital. 11 participants were in the 40-54 age range, and 2 in the 55-70 with scores increased accordingly. The medication scores ranged from 0-1.25; 4 participants did not require medication, 5 required IV narcotics, and the rest received Non-narcotic or Narcotic PO. The imaging scores ranged from 0-0.75. Eight patients did not receive imaging, 10 patients had only x-rays and 14 needed MRI or CT. All imaging results were negative. After category summation, QMIS totals ranged from 0.63 to 7.8; average of 2.92$\pm$1.69.

The QMIS provides a gradient to differentiate patients with various levels of non-serious injury.

Correlation with CES-D. Some depression symptoms were reported in all patients; CES-D ranged from 5 to 44 and averaged 20.9$\pm$12.69. Two patients met diagnosis for depression. The linear correlation analysis indicated positive correlation between the QMIS total summative score and the CES-D score (correlation coefficient R=0.366; p=0.039 Figure 1).

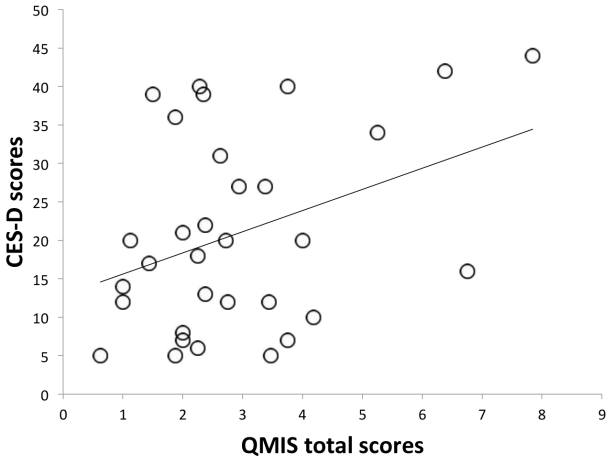

Figure 1. Correlation between CES-D scores and QMIS scores. The CES-D scores and QMIS scores are positively correlated.

Discussion

The lack of quantitative evaluation of minor injury severity impedes research on post-MVC psychiatric symptoms. This study introduces a quantitative minor injury scale that considers injury characteristics and physician's assessments. This objective scale of minor injury severity correlated positively with depression symptoms within 3 weeks post-MVC.

Reasoning of Scoring Method. The currently accepted injury scales were primarily designed for survival prediction and thus are not sensitive in the minor injury range commonly seen after MVC. The research questions that require minor injury cohorts cannot adequately compare the injury severity of their participants. The QMIS allows additive analysis of an injury and accounts for variation between similar symptoms. By incorporating medication and imaging scores, the physician's professional objective opinion impacts the severity score of the injury. An elderly participant presenting with a "shoulder strain" requiring x-ray and IV narcotics is rated higher than a "shoulder strain" that requires no medication or imaging.

Initial Injury Severity Correlation. The positive correlation of QMIS scores and CES-D suggests severity of minor injury may be related to post-MVC depression symptoms. Previous research supports injury severity correlating with psychiatric morbidity (2, 10, 11). However, these studies involved seriously injured survivors, as those with minor injuries were not previously distinguishable by scales. The QMIS creates a gradient of injury severity, allowing analysis of the impact minor injuries have on post-MVC recovery. This correlation suggests

that injury severity, even in non-serious patients, may increase the risk of a psychologically disabling condition, like depression. These initial findings justify further validation of this pilot scale for use in future study of the minor injury patient cohort and their outcomes.

Limitations. A potential problem with the QMIS is that medication and imaging use can vary between physicians. These portions hold less weight, but were included to address physical injury symptoms with the same "name" but varying severity. This is a pilot study in which further evaluation and validation is needed in a larger population.

Conclusions. The proposed QMIS provides a gradient to differentiate severities of minor injuries after MVC, and the scores may relate to psychological conditions in subsequent weeks. The further development of QMIS may generalize the usage of this scale to minor injuries caused by other types of trauma. The relationship of severity of minor injuries and physical and psychosocial consequences of trauma will continue to be examined in future study.

ACKNOWLEDGMENTS. Funding: [1]Translational Research Stimulation Award (TRSA) of ProMedica Health System. Proposal N-122930-01; [2] William Bauer fMRI Research Fund for XW Grant No.:2401957; [3] University of Toledo New Faculty Start-up Fund for XW

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Appendix

Table 1. QMIS Score sheet

Injury Symptom Score	
Abrasion contusion minor laceration not to face/head	1-2 (place) = [0.25] 3-4 = [0.5] 5+ = [0.75]
Abrasion contusion minor laceration to face/head	1-2 (place) = [0.75] 3+ = [1]
Strain or Sprain	1 (place) = [1] 2-3= [1.5] 4+ = [1.75]
Laceration not to face head requires sutures 4-20 cm	1 (place) = [1] 2= [1.5] 3+ = [2]
Laceration face/head require sutures 3-10 cm	1 (place) = [1.5] 2= [2] 3+ =[2.5]
Penetrating wound not affecting organs	1 (place) = [1] 2= [1.5] 3+= [2]
Closed undispalced fracture (FX) Phalange	[1.75]
FX radius ulna carpal metacarpal fibula	[2.25]
FX clavicle humerus tibia 1 rib	[2.75]
FX 2-3 ribs no PTX	[3.25]
FX Pelvis	[3.75]
Hit head dazed but no LOC	[0.5]
Hit Head LOC<1 min	[3]
Hit Head LOC >1 min <1hr	[4]
TOTAL	
Hospital Admit Score	
[33% * (Injury symptom score)] * number of days of stay	
TOTAL	
Age Score	
18-39	[0]
40-55	[12.5% * (Injury symptom score)]
56+	[25% * (Injury symptom score)]
TOTAL	
Max Medication Score	
Non-Narcotic PO	[0.25]
Non-Narcotic INJ Narcotic PO	[0.75]
Narcotic IV	[1.25]
TOTAL	
Imaging Score	
1-3 X-ray scan	[0.125]
4+ Xrays	[0.25]
1 CT	[0.375]
2+ CT	[0.5]
MRI	[0.5]
TOTAL	
TOTAL QMIS SCORE:	