Assessing the Accuracy of "Serious Injury" Reporting with the Implementation of the New MMUCC KABCO Definition

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ABSTRACT

Across the United States large discrepancies have been found between law enforcement officer's (LEOs) injury severity assessments and medically assessed health outcomes of crash victims. To better monitor traffic safety serious injury reporting is now federally mandated, making accurate injury severities more important. New federal KABCO injury severity definitions introduced to standardize and add clarity may help reduce inaccuracies in LEO assessments. Wisconsin implemented the new definitions January 1, 2017. Linked crash and medical data from 2009 through 2016 was compared with data from 2017 using the new definitions to determine impacts on injury severity accuracy. Large differences were evident between injuries assessed 'A' and 'B' or 'C' suggesting LEOs are able to differentiate between more serious injuries and less severe injuries. However, despite this difference, approximately two-thirds of crash victim's injury severities were overestimated (assessed more severely than actual health outcomes) from 2009 through 2017. Underestimation of injury severity decreased from 3.5% to 2.5% after the KABCO definition changes. Furthermore, injuries assessed as minor by medical professionals were less often considered "serious injuries" by LEOs. LEO's assessment of body regions with more superficial injuries, such as the face, improved. Assessments of body regions with more internal, occult injuries, such as the thorax and abdomen also improved. More accurate assessments may be due to the added clarity of the new definitions. Despite continuing issues, the definition change does suggest that injury severity assessments have improved, which in turn may lead to more accurate traffic safety data.

Keywords: Law enforcement, crash data, injury severity, KABCO, CODES

INTRODUCTION

Injury severity assessments are a critical piece of information used when evaluating traffic safety. These assessments are one of the many duties of law enforcement officers (LEOs) at the scene of a crash. However, past research has shown large discrepancies between LEO assessed injury severity and actual health outcomes assessed by medical practitioners (*1-5*). Inaccuracies in injury severity assessments are a critical issue because these injury data are used for safety and cost-benefit analyses which in turn influence the identification of future safety improvement projects. A new, standardized national definition was adopted that provides additional clarity when assessing injury severity at the scene of a crash. This paper investigates the effectiveness of these new definitions in bringing injury severity ratings and actual health outcomes into parity.

Injury severity assessments by LEOs are rated on the KABCO scale. KABCO is rated on a descending scale of severity where 'K' is a fatality and 'O' is a crash resulting in only property damage. 'A', 'B', and 'C' correspond to decreasing severity of injuries, respectively. The KABCO scale is used by LEOs who are not typically medical professionals and are required to complete a multitude of other tasks at the scene of the crash.

Across the United States LEOs have historically overestimated approximately two-thirds of crash victims' injury severities (*1, 2, 4-6*). In other words, LEOs tend to classify injuries as KABCO 'A' injuries when 'B' or 'C' would be more appropriate. Past research has found crash type, gender, time of day, and age affect officer severity estimates (*1, 4*). Overestimation of serious injuries are more common when a significant amount of bleeding is present (*6*). However, 'KA' injuries have been found to be associated with more serious injuries, and crash victims were more likely to be more seriously injured given higher KABCO ratings (*7*). Inaccurate injury severity assessments can skew safety estimates (e.g., in hotspot analyses) and result in a misallocation of limited transportation funds.

Beginning with the Moving Ahead for Progress in the 21st Century Act (MAP-21), and continuing through the most recent surface transportation law, the Fixing America's Surface Transportation (FAST) Act, a performance-and outcome-based surface transportation program was implemented. These laws established national performance goals in several areas related to the surface transportation program. Specifically, a performance goal for safety was laid out "to achieve a significant reduction in traffic fatalities and serious injuries on all public roads" (*8*). To measure each State's effectiveness toward achieving this goal, States are required to report not only fatal crashes, but also serious injury crashes. However, there was not a uniform "serious injury" definition across state lines, and even across jurisdictions and LEOs differences in injury severity assessment existed. The USDOT mandated a "single, national definition for States to report serious injuries" (*9*). This new definition, "Suspected Serious Injury (A)", was adopted from the Model Minimum Uniform Crash Criteria (MMUCC) 4th edition, and States were required to adopt this new definition for serious injury reporting by April 15, 2019. Alaska, Arkansas, Connecticut, Iowa, and Wisconsin had implemented the new KABCO definition prior to the April, 2019 mandate (*10*).

As of January 1, 2017 Wisconsin had implemented a new crash report form compliant with the new federal rule for serious injury definitions. Prior to this update, the police crash report form in Wisconsin had not been updated since 1998 (*11*). Wisconsin used the definition "Incapacitating Injuries" for KABCO 'A', defined as "any injury other than a fatal injury which prevents the injured person from walking, driving, or from performing other activities which he/she performed before the accident". Under this definition, 67% of 'A' crashes were overestimated in Wisconsin (*1, 2*). Over 1,000 hours of "Train the Trainer" sessions were

provided to those who then trained LEOs across the state to prepare for the launch of the new crash report form, including the new KABCO definitions. Wisconsin's compliance with the new serious injury reporting requirements provides an early opportunity to examine the impact these new definitions have on the accuracy of LEO injury severity assessment.

To compare LEO injury severity assessments to medical assessments, the Crash Outcome Data Evaluation System (CODES) was utilized. CODES is a database that links crash data from law enforcement to hospital data. The CODES database contains the KABCO assessment by LEOs from the scene of the crash, as well as the injury data assessed by medical professionals, and additionally contains other crash data such as location, time of day, vehicle types, driver behavior, and crash types (*12*). The CODES data links medical data with Wisconsin Department of Transportation crash data using probabilistic linkage pre-2013 and exact linkage 2013 and onward (*13*). Using the CODES data direct comparisons between LEO and medical professional injury severity assessments were made.

The objective of this research was to investigate the impact of new serious injury definitions on LEO injury severity assessment at the scene of the crash. Further, the research determined body regions and injury types that officers have difficulty assessing accurately at the scene of the crash. Finally, based on the outcomes of this research, guidance will be provided to assist training officers on best practices for ensuring the most accurate injury severity assessment possible at the scene of the crash.

BACKGROUND

KABCO Injury Severity Scale

In 1966, the National Safety Council (NSC) developed the KABCO scale (*6*). This scale was adopted by the states to report injury severity at the scene of a crash. While the naming conventions and definitions were largely left up to the State's discretion, most states were found to use the terms "incapacitating" or "disabling" for serious injuries (*14*). Further, most states were found to use definitions similar to those recommended by MMUCC 3rd edition, a voluntary guideline for standardizing crash data. In an effort to further standardize definitions, the 4th edition of the MMUCC was released in 2012. The MMUCC 4th edition injury definitions were subsequently carried forward into the 5th edition of the MMUCC, published in 2017 (*15*).

The 4th edition of the MMUCC was the first major change to the KABCO scale since its inception. KABCO name changes from 3rd edition to the 4th and 5th edition are shown in Table 1. This edition not only changed injury severity names but also provided clear examples of specific injuries for each severity level. The new edition also brought significant clarity to a serious injury 'A', with the following guidance:

> "A suspected serious injury is any injury other than fatal which results in one or more of the following:
>
> - Severe laceration resulting in exposure of underlying tissues/muscle/organs or resulting in significant loss of blood,
> - Broken or distorted extremity (arm or leg),
> - Crush injuries,
> - Suspected skull, chest or abdominal injury other than bruises or minor lacerations,
> - Significant burns (second and third degree burns over 10% or more of the body),

- Unconsciousness when taken from the crash scene, and
- Paralysis."

Examples are also provided for 'B' and 'C' level injuries, although the guidance for serious injury 'A' is the most defined.

TABLE 1 KABCO Attributes in Wisconsin

KABCO	MMUCC 3 (1994-2016)	MMUCC 4/5 (2017-)
K	Fatal Injury	Fatal Injury
A	Incapacitating Injury	Suspected Serious Injury
B	Non-Incapacitating Injury	Suspected Minor Injury
C	Possible Injury	Possible Injury
O	No Injury	No Apparent Injury

Abbreviated Injury Severity (AIS) Scale

Medical practitioners rate the injury severity of traffic crash victims on a scale known as the Abbreviated Injury Scale (AIS). The AIS is an internationally accepted standard developed by the Association for the Advancement of Automotive Medicine (AAAM) in 1969 (*16*). The AIS scale was first published in 1971, and most recently updated in 2015. The AIS is a threat-to-life scale that rates injury severity from 1 to 6 where: 1 is a minor injury, 2 is a moderate injury, 3 is a serious injury, 4 is a severe injury, 5 is a critical injury, and 6 is a maximum injury (or fatality). Scores are determined for each of the following body regions:

- Head,
- Face,
- Neck,
- Thorax,
- Abdomen,
- Spine,
- Upper extremities, and
- Lower extremities.

To determine the overall injury severity of a crash victim there are two main scales derived from the AIS: the Injury Severity Score (ISS) and the Maximum Abbreviated Injury Score (MAIS). ISS determines the overall injury severity by taking the sum of the squares of the AIS scores for the three most severely injured body regions, ranging from zero to 75. A score of 16 or greater is typically considered a serious injury, while fatalities are automatically coded 75 (*17*). MAIS scores are assigned simply by assigning the most severe injury across all body regions. The International Road Traffic Accident Database (IRTAD) recommends MAIS scores of three or higher are serious injuries (*18*).

ANALYSIS OF WISCONSIN CODES DATA

CODES data available with Wisconsin Department of Transportation from 2009 through 2017 were analyzed. The entire dataset was split into two subsets. Subset 1 with the MMUCC 3 injury definition: data from 2009 through 2016 used the former KABCO 'A' definition of "Incapacitating Injuries"; and Subset 2 with the new MMUCC 4/5 injury definition: the data

from 2017 used the new MMUCC 4th/5th edition compliant "Suspected Serious Injury" definition. Table 2 shows the total number of linked crashes per year from the CODES database.

TABLE 2 Linked Crashes Per Year

Year	Total Crashes	# of Linked Crashes	% Linked
2009	109,991	24,089	21.9%
2010	108,808	23,332	21.4%
2011	112,516	22,738	20.2%
2012	109,385	22,785	20.8%
2013	118,254	20,228	17.1%
2014	119,736	19,393	16.2%
2015	121,613	20,568	16.9%
2016	129,051	19,551	15.1%
2017	122,645	20,480	16.7%

The average number of linked crashes over the analysis period was 21,462 (s =1,767) ranging from a maximum of 24,089 linked crashes in 2009 to a minimum of 19,393 in 2014. Crash linkage methodology changed in 2013 from probabilistic to exact linkage. The linkage change resulted in the number of linked crashes dropping from an average of 21.1% of crashes linked via probabilistic linkage to 16.4% via exact linkage.

From the linked data of person level crash data that contained both KABCO and MAIS injury severities matrices were made comparing the KABCO assessments to the MAIS scores, similar to past research (*1, 2*). Comparison matrices of KABCO injury severity and MAIS scores are shown in Table 3. Each column represents a KABCO injury severity, while the rows show the frequency and percentages of MAIS scores for a given KABCO severity rating. Table 3a shows the comparison matrix for the pre-MMUCC 4th edition compliant years 2009 through 2016, while Table 3b shows the comparison matrix for the MMUCC 4th edition compliant KABCO definitions.

TABLE 3 Comparison Matrix of KABCO and MAIS Scores from (a) 2009-2016 (Pre-implementation) and (b) 2017 (Post-implementation)

	KABCO				
MAIS	O	C	B	A	K
1 (minor)	20,886 (91.5)	56,548 (87.9)	47,706 (75.7)	7,514 (35.2)	0 (0)
2 (moderate)	1,778 (7.8)	6,538 (10.2)	11,466 (18.2)	6,142 (28.8)	0 (0)
3 (serious)	92 (<1)	844 (1.3)	2,759 (4.4)	4,567 (21.4)	0 (0)
4 (severe)	52 (<1)	339 (<1)	1,042 (1.7)	2,683 (12.6)	0 (0)
5 (critical)	6 (<1)	31 (<1)	76 (<1)	406 (1.9)	0 (0)
6 (maximum-fatal)	1 (<1)	5 (<1)	3 (<1)	16 (<1)	1,184 (100)
Total	22,815	64,305	63,052	21,328	1,184

(a)

	KABCO				
MAIS	O	C	B	A	K
1 (minor)	3,445 (95.6)	5,488 (90.1)	6,408 (79.6)	683 (26.2)	0 (0)
2 (moderate)	138 (3.8)	507 (8.3)	1318 (16.4)	948 (36.3)	0 (0)
3 (serious)	18 (<1)	85 (1.4)	281 (3.5)	821 (31.5)	0 (0)
4 (severe)	0 (0)	5 (<1)	25 (<1)	98 (3.8)	0 (0)
5 (critical)	1 (<1)	7 (<1)	17 (<1)	60 (2.3)	0 (0)
6 (maximum-fatal)	0 (0)	0 (0)	0 (0)	0 (0)	127 (100)
Total	3,602	6,092	8,049	2,610	127

(b)

NOTE: Percentage is given in parentheses. Darker shading indicates overestimated crashes; lighter shading indicates underestimated crashes.

Table 3 highlights the KABCO crashes that were overestimated and underestimated. Determination of overestimation and underestimation was based on the IRTAD recommendation of a MAIS score of 3+ corresponding to a serious injury (*18*). KABCO severities of 'A' with a corresponding MAIS score of 1 or 2 were considered overestimated, while KABCO 'B', 'C', and 'O' severities with a MAIS score of 3+ were considered underestimated. For KABCO 'A' crashes, the frequency of MAIS 1 crashes changed from 35.2% to 26.2% after the KABCO definition change, suggesting LEOs may be assigning less minor injuries to KABCO 'A'. From 2009 through 2016 an average of 63.7% of crashes were overestimated and 3.5% were underestimated. In 2017, using the new definition for KABCO 62.5% of injury severities were overestimated and 2.5% were underestimated. Figure 1 shows the rate of overestimation and underestimation by year.

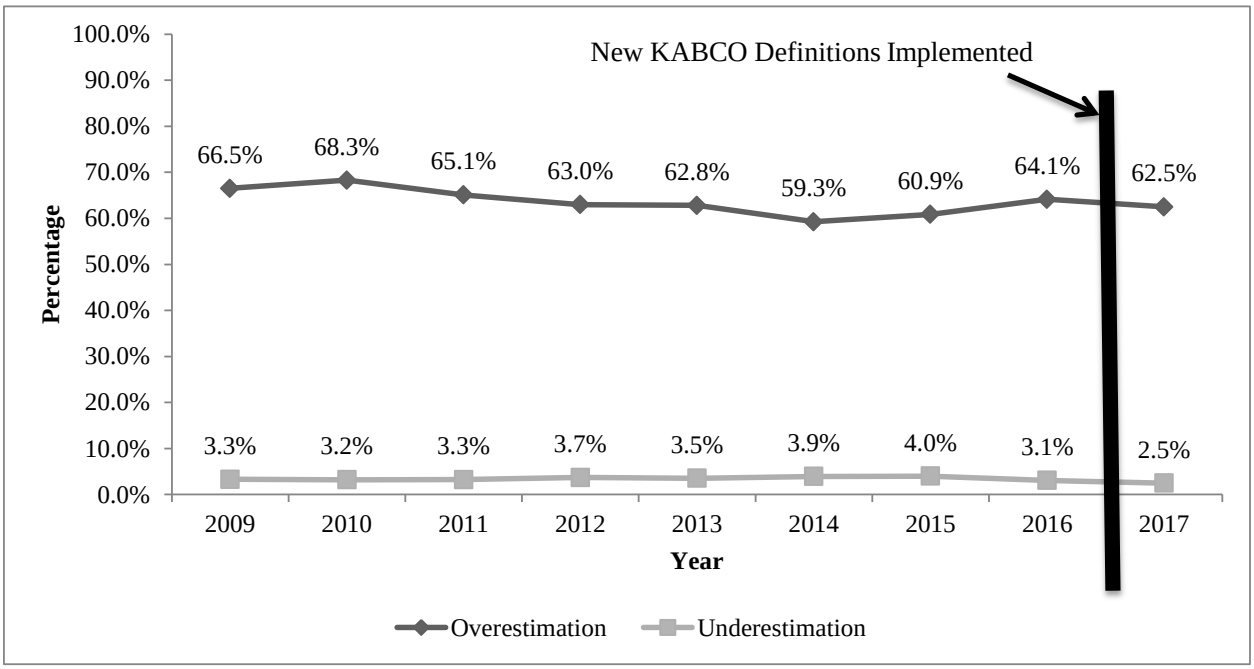

FIGURE 1 Overestimation and Underestimation of KABCO Injury Severity by Year

Overestimation ranged from a high of 68.3% of crash victims in 2010 to a low of 59.3% in 2015. While the overestimation rate of 62.5% with the new KABCO definition was lower than the average from 2009 through 2016, the rate was not the lowest observed and was within one standard deviation of the 2009-2016 average (63.7±2.9%). Underestimation using the old definitions was much more consistent over time, ranging from a maximum of 4.0% of crash victims in 2015 to a low of 3.1% in 2016. The underestimation rate using the new KABCO definition resulted in the lowest underestimation, and was over three standard deviations away from the previous mean (3.5±0.3%). While the rate of overestimation remains high and consistent over time, the low rate of underestimation is promising and suggests that while LEOs are still overly conservative when an injury is evident, they are less inclined to rate non-serious injuries as highly as in the past.

The weighted average MAIS score for each KABCO rating was calculated based on the KABCO-MAIS matrices in Table 3. KABCO 'A' crashes should be above a three on the MAIS scale. KABCO severity 'B' should have a lower score, while 'C' should have the lowest score. Additionally, with the new MMUCC 4th edition KABCO definitions, the average MAIS score for a "Suspected Serious Injury" (KABCO 'A') would ideally increase as LEOs should have clearer guidance about what constitutes an 'A' injury. Furthermore, the differences between the KABCO severity ratings should also be more stratified as definitions and differences in severity levels were made more explicit. Figure 2 shows the weighted average MAIS score for each KABCO severity rating both before the KABCO definition changes, and after the MMUCC 4th edition definitions went into effect.

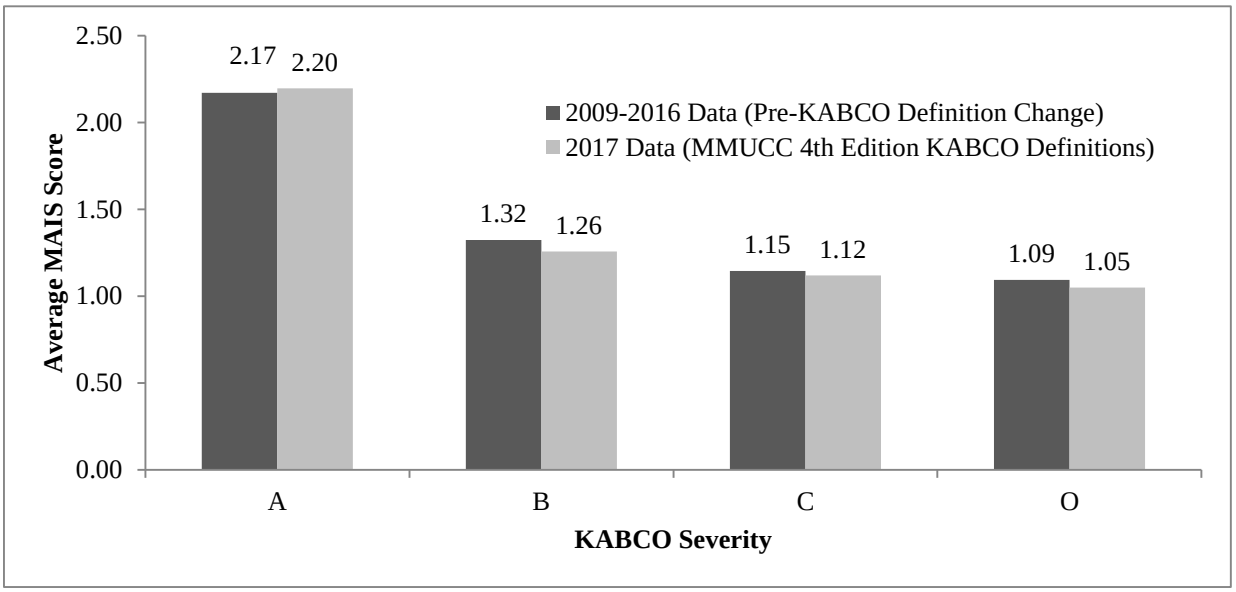

FIGURE 2 Average MAIS Scores per KABCO Severity Ratings

Figure 2 shows that KABCO 'A' ratings were well below the expected minimum level of three (before and after the KABCO changes), consistent with the high levels of overestimation. The results do show an increase in serious injury KABCO 'A' assessments (from 2.17 under the previous definitions to 2.20 with the new MMUCC 4th edition definitions). The Mann-Whitney U test was conducted between the previous KABCO definition and the new definition. All ABCO levels had significantly different distributions ($p<0.001$) than the previous KABCO

definition data. While the distributions changed significantly, the average MAIS scores were not practically different. As noted in Table 3, the proportions of MAIS 1 and 2 for KABCO ‘A’ did switch from 35.2% and 28.2% to 26.2% and 36.3%, respectively.

The scores for KABCO severities ‘B’ and ‘C’ were lower by approximately one point on the MAIS scale. Additionally, the MAIS scores decrease for decreasing KABCO injury severity, although the differences between ‘B’ and ‘O’ are 0.23 and 0.20 for the previous KABCO definitions and the MMUCC 4th edition definitions, respectively. The results do not suggest that LEOs rate property damage crashes (KABCO ‘O’) incorrectly frequently, as only persons with hospital or transport data are linked. However, the results show little difference between injury severity assessment of KABCO ‘B’ and KABCO ‘C’ injuries, and furthermore, little difference between persons that LEOs believe have no injuries but suffer minor injuries from the crash. However, Figure 2 makes clear LEOs can discern between more serious injuries ‘A’ and less severe injuries, similar to findings in past research (*7*).

Analysis of KABCO “A” Injuries by Body Region

Given the overestimation of serious injuries (KABCO ‘A’), each crash victim’s injured body regions were examined to determine which body regions LEOs were classifying as serious injuries, and which are contributing to overestimation. Furthermore, whether the body regions injured changed based on the changed KABCO ‘A’ definition was examined. Figure 3 shows the average MAIS scores for each body region both before the KABCO definition change and after to MMUCC 4th edition definitions.

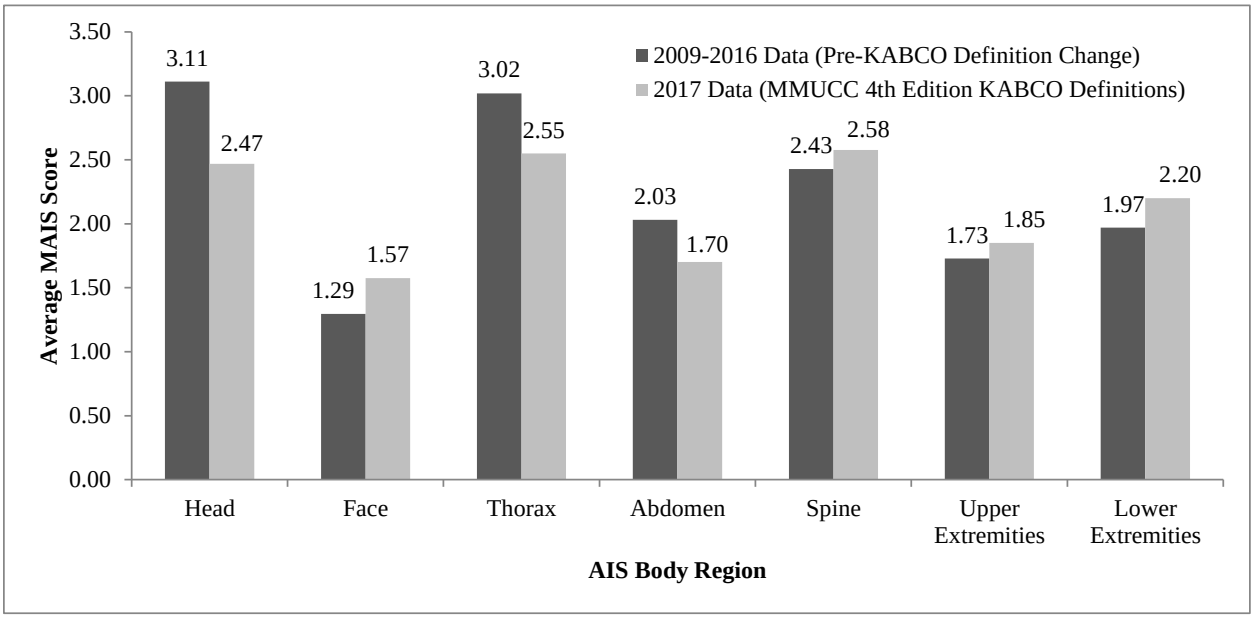

FIGURE 3 Comparison of MAIS Scores for ‘A’ Injuries

Again, scores should be at or above three on the MAIS scale for ‘A’ crashes. Furthermore, with the additional guidance and explicit examples the scores after the KABCO definition changes should ideally be higher than with the previous KABCO definition. Under the old definition body regions head and thorax both had MAIS ratings above three, while under the new definition no body region was 3+ on the MAIS scale. Under the new KABCO definitions the body regions face, spine, and both upper and lower extremities increased MAIS scores.

Analysis of Overestimation by Body Region

Knowing that the MAIS scales for injured body regions that LEOs assessed as KABCO 'A' injuries rarely qualified as "serious injuries", overestimated injury severities were examined. Figure 4 shows the proportion of overestimated crashes for each body region, both before the KABCO definition change and after.

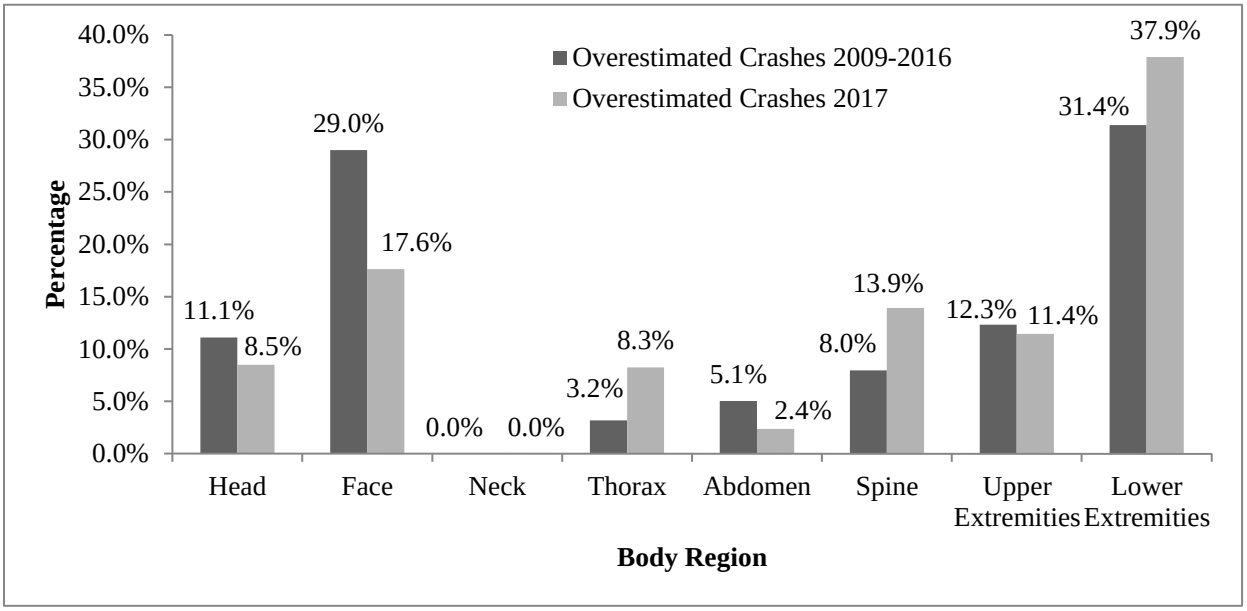

FIGURE 4 Comparison of Overestimated Injured Body Regions

Lower extremity injuries were the most overestimated injuries both before and after the KABCO definition change (31.4% and 37.9%, respectively). The face was the next most overestimated body region, both before and after the definition change (29.0% and 17.6%, respectively). Part of this overestimation may be due to the definitions officers use when making injury severity assessments. Considering lower extremities, the past KABCO definition describes a serious injury as "any injury... that prevents a person from walking, driving" and the new definition includes "broken or distorted extremity" including lower extremities. However, considering the AIS scale is a threat-to-life scale lower extremity injuries such as breaks are not always considered serious. Face injuries have historically been a body region that LEOs overestimate (*1*). Overestimation of face injuries, in part, is due to the assumed severity of superficial injuries to the face, which typically involve lacerations resulting in the appearance of heavy blood loss. Severity of face injuries is complicated by new serious injury 'A' guidance suggesting "severe lacerations... resulting in significant loss of blood" and "suspected skull... injury... other than... minor lacerations". However, given LEO's limited medical knowledge assessing these injuries and determining which lacerations are minor or severe given a loss of blood usually results in more conservative estimation that assumes injuries are more severe than they actually were.

Body regions of head, face, abdomen, and upper extremities saw less overestimation with the new KABCO definition ("Suspected Serious Injury") compared to the previous definition. However, body regions thorax, spine, and lower extremity had larger proportions of overestimation. Chi-square tests were performed to compare overestimation of KABCO 'A' injuries from the previous definition to the changed KABCO definitions. Additionally, odds

ratios (Θ) were calculated for each body region. Injuries to the neck were not considered as the sample sizes were too small. Table 4 shows the results of the chi-square tests and the odds ratios for overestimation to each body region.

TABLE X χ^2 Results for Overestimated Body Regions Before and After KABCO Changes

Body Region	X^2 (df = 1)	P-Value	Significant?	Θ
Head	13.431	<0.001	Yes	1.41
Face	9.353	0.002	Yes	1.21
Neck	-	-	na	na
Thorax	21.389	<0.001	Yes	0.61
Abdomen	17.817	<0.001	Yes	2.02
Spine	182.618	<0.001	Yes	0.34
Upper Extremity	70.167	<0.001	Yes	0.77
Lower Extremity	10.373	0.001	Yes	1.14

Each body region was found to have significantly different overestimation rates when comparing KABCO definitions before and after the changes. The largest overestimation differences observed were found in the abdomen region where injuries were two times more likely to be overestimated under the old KABCO definitions. Conversely, spine injuries were nearly three times more likely to be overestimated given the new KABCO definition (Θ=0.34). Lower extremity injuries showed the least change between KABCO definition changes (Θ=1.14).

Analysis of Underestimation by Body Region

Comparisons of underestimated body regions were also undertaken. A crash victim's injury severity was considered underestimated if the officer's KABCO injury severity estimation was 'B', 'C', or 'O' while the MAIS score was three or higher, corresponding to a serious injury. A comparison of the proportions of each body region injured under the old KABCO definition and under the new MMUCC 4th edition compliant KABCO definition is shown in Figure 5.

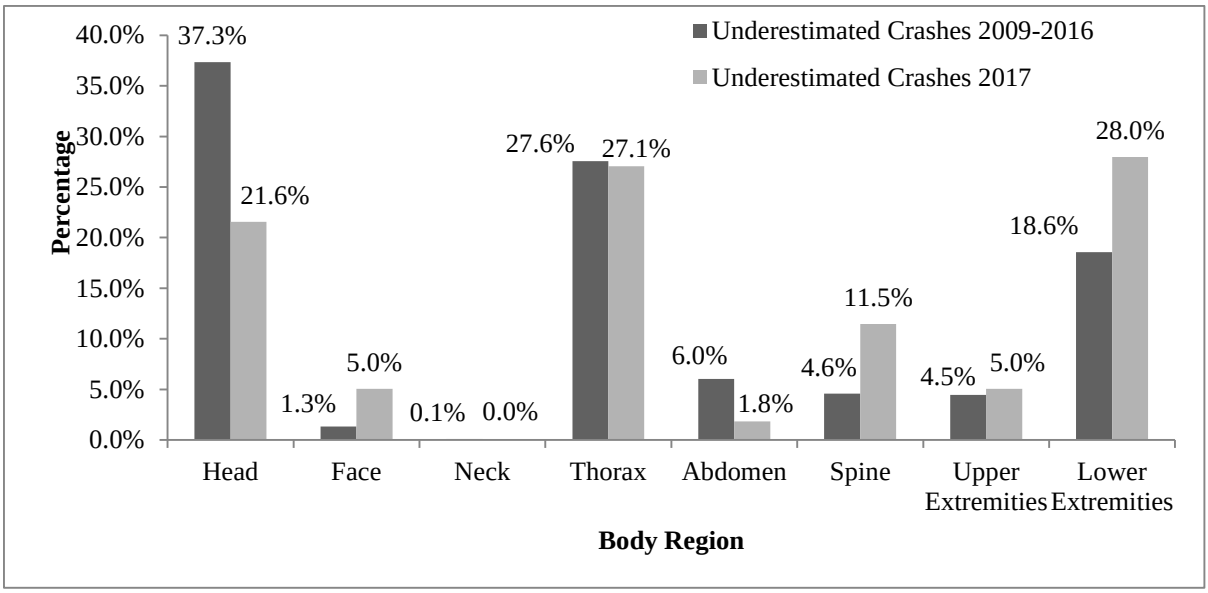

FIGURE 5 Comparison of Underestimated Body Regions

Head, thorax, and lower extremities were the most underestimated body regions by LEOs both before and after KABCO definition changes. These three body regions accounted for 83.5% and 76.7% of underestimation before and after the definition changes, respectively. Head, thorax, and abdomen had less underestimation after the implementation of the MMUCC 4th edition compliant KABCO definitions. Face, spine, and upper and lower extremities had larger proportions of underestimation after the KABCO definition changes. The results of the chi-square test comparing before and after differences in underestimation, as well as the resulting odds ratios are shown in Table 5. Again the body region of neck was excluded from statistical testing due to sample size.

TABLE 5 χ^2 Results for Underestimated Body Regions Before and After KABCO Changes

Body Region	X^2 (df = 1)	P-Value	Significant?	Θ
Head	110.788	<0.001	Yes	2.98
Face	29.801	<0.001	Yes	0.29
Neck	-	-	na	-
Thorax	134.621	<0.001	Yes	3.11
Abdomen	22.070	<0.001	Yes	4.64
Spine	33.631	<0.001	Yes	0.41
Upper Extremity	0.021	0.885	No	0.97
Lower Extremity	10.133	0.001	Yes	1.36

All body regions except upper extremity injuries were found to be significantly different when comparing underestimation during the past KABCO definitions to the new KABCO definitions. The abdomen body region had the largest drop in underestimation, where injuries were 4.64 times more likely to be underestimated under the old definitions when compared to the new definition. Injuries to the head and thorax were approximately three times more likely to be underestimated when considering data using the previous KABCO definition. Face injuries showed the largest difference between the two definitions, with injuries more than three times

more likely to be underestimated given the new definition (Θ = 0.29). Spine injuries were 2.5 times more likely to be underestimated given the new definition (Θ = 0.41).

CONCLUSIONS

Comparisons with medical data show LEOs have historically overestimated the injury severity of approximately two-thirds of KABCO 'A' crashes. Federal guidelines have mandated new standardized KABCO definitions to be used by all states. These changes may provide LEOs clearer guidance when assessing injury severity at the scene of a crash leading to more accurate injury severity assessments. More accurate assessments provide a more accurate picture of traffic safety, which in turn leads to a better allocation of safety improvement funds. In Wisconsin, the new definition was implemented in 2017 after providing extensive training on the new crash report form and KABCO definitions. Linked data containing both medically assessed injury severity and LEO KABCO injury severity from 2009 through 2017, including pre- and post-MMUCC 4 implementation data was considered for this analysis.

Throughout the study years, approximately two-thirds of KABCO 'A' crashes were overestimated. However, injuries assessed as 'A' had an average MAIS score of approximately two versus 'BCO' crashes that averaged MAIS scores of approximately one. The difference between KABCO injury severities 'A' and 'BCO' suggest officers can discern between more serious injuries and less severe injuries, similar to results in past research.

Results of the comparison analysis between the old KABCO definitions (2009-2016 data) and the new MMUCC 4th edition KABCO definitions (2017 data) can be summarized thusly. After the definition change:

- The proportion of KABCO 'A' crashes that were actually minor injuries (MAIS 1) decreased from an average of 35.2% to 26.2%.
- Underestimated injury severities decreased to 2.5% (from an average of 3.5±0.3%).
- Weighted average MAIS scores stratified by KABCO severity levels did significantly change, although the differences were not practically significant (e.g., KABCO had an average MAIS score of 2.17 under the old KABCO definitions, which raised to 2.20 after the new definition was implemented).
- Most body regions had significantly different rates of over-and under-estimation (compared to previous KABCO definitions), with the exception of underestimation of upper extremity injuries.
- Areas with superficial injuries, such as face injuries, were less likely to be overestimated. Further, officers were less likely to underestimate body regions with more occult injuries that are harder to detect, such as thorax and abdomen.

In conclusion, while the rate of overestimation of injury severity has remained steady, the change in the KABCO definition shows areas of promise. Officer's rate minor injuries as less severe, and body regions that have historically been difficult to assess accurately are becoming more in line with actual health outcomes. However, there remain significant issues and areas for improvement in injury severity assessment. Officers should take care when assessing extremity and face injuries to ensure the injury is actually severe. Furthermore training should be undertaken to ensure officers are fully aware of the new definitions, where to find them when in the field, and to consult them when necessary when initiating an injury severity. As the costs of crashes are examined, stratifying KABCO 'B' and 'C' crashes may not be useful as the severities

of these crashes are similar. Future work will continue to monitor progress of KABCO assessments in Wisconsin and compare results across state lines as other states implement the new KABCO definitions. Furthermore, additional training on injury severity assessment for LEOs will provide an opportunity to determine the effectiveness of training and how training can be improved to improve the accuracy of injury severity assessments.

AUTHOR CONTRIBUTIONS

The authors confirm contributions to the paper as follows: study conception and design: B. Burdett, Z. Li, A. R. Bill, D. A. Noyce; data collection: B. Burdett; analysis and interpretation of results: B. Burdett, Z. Li; draft manuscript preparation: B. Burdett; Z. Li. All authors reviewed the results and approved the final version of the manuscript.

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