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### Title

Evaluation of Injury Severity Updates in California Collision Data

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1 **EVALUATION OF INJURY SEVERITY UPDATES IN CALIFORNIA COLLISION**  
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**1 ABSTRACT**

2 Fatal or injury collisions in California must be reported to the California Highway Patrol (CHP)  
3 for inclusion in the Statewide Integrated Traffic Records System (SWITRS). After records have  
4 been entered into SWITRS they are made publicly available and are accessible through the  
5 CHP's report and data retrieval site called I-SWITRS. However, records accessed in SWITRS  
6 are considered provisional and can be updated several years after initial entry. This includes the  
7 injury severity level of collisions. If the collision data was accessed prior to an injury severity  
8 update, the agency retrieving the data may unknowingly be working with an outdated version.  
9 This can have an impact on government agencies use of data driven safety analyses to apply for  
10 safety improvement funding in order to achieve key safety goals in reducing fatal and serious  
11 injury collisions. This paper evaluated the frequency and level of injury severity changes for  
12 severe injury and fatal collisions that occurred in 2016 and which were retrieved at four different  
13 times between March 2017 and June 2018. In total, 94 injury collisions were upgraded to fatal  
14 collisions (2.653%) and 2 fatal collisions were downgraded to severe injury collisions (0.056%)  
15 out of the 3,543 total fatal collisions that occurred in 2016. The authors concluded that  
16 government agencies need to perform regular checks of their data to ensure that fatal and severe  
17 injury collisions are properly accounted for to maximize their ability to achieve safety  
18 performance targets.

19

20 *Keywords:* Collision Database, SWITRS, Injury Severity

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## 1 INTRODUCTION

2 Fatal or injury collisions in California are required to be reported to the California Highway  
3 Patrol (CHP) for inclusion in the Statewide Integrated Traffic Records System (SWITRS). After  
4 records have been entered into SWITRS they are made publicly available and are accessible  
5 through the CHP's report and data retrieval site called I-SWITRS (*I*). However, records accessed  
6 in I-SWITRS are considered provisional until they have been frozen to updates by CHP, which  
7 could be one or more years later. Many users may be unaware of this timeline and assume  
8 whenever they retrieve records from I-SWITRS that these records have been finalized in  
9 SWITRS. Even if users are aware of the possibility of updates, they may require the latest data  
10 available and it is not feasible to wait several years. Therefore, numerous localized versions of  
11 data may exist based on the information that was current when the records were extracted from I-  
12 SWITRS. This paper sought to answer the questions of what types of differences are possible,  
13 and what their potential impact may be on data driven safety analysis due to the changes.  
14

### 15 **Traffic Collision Report Transmittal and SWITRS Input Schedule and Requirements**

16 The CHP Collision Investigation Manual outlines the requirements for initial submission of  
17 traffic collision reports by local allied law enforcement agencies and CHP field offices. The  
18 transmittal schedule states that traffic collision reports should be submitted to the CHP as follows  
19 (2):  
20

- 21 • Within ten working days from the date of the collision
- 22 • Collision reports that cannot be completed due to unusual circumstances may be retained  
23 at the local level for a maximum of 15 days.
- 24 • A preliminary INVESTIGATION shall be submitted when the Traffic Collision Report  
25 cannot be completed within the 15-day limit.
  - 26 1) A preliminary INVESTIGATION shall include at a minimum:
    - 27 a) Number of parties,
    - 28 b) Names,
    - 29 c) Injuries,
    - 30 d) A summary of the sequence of events that lead to the collision, and
    - 31 e) A scene description.

32 NOTE: This is especially important when a fatal injury has occurred. The  
33 "Special Conditions" box shall be marked "Preliminary."  
34

- 35 2) "Preliminary" shall not be entered in the "Special Conditions" box when the only  
36 unresolved information is the status of the charges to be filed.
- 37 3) Commanders shall make every effort to keep the number of preliminary  
38 INVESTIGATIONS to a minimum.

39 These requirements show that special consideration is given to allow for more time to complete  
40 fatal traffic collision reports, however it does not mean that the preliminary investigation reports  
41 are added to the SWITRS database. Regardless, submitting reports for most collisions within ten  
42 working days of the collision would naturally lead to situations where changes may be necessary,  
43 especially to injury levels. The process and timeline to make those types of changes are not  
44 described. Additionally, after submission of the initial report, the CHP must still enter the record

1 into the SWITRS database. However, exact numbers and timelines for entering reports are not  
 2 published. There is a general lack of reporting metrics or feedback regarding reports being  
 3 entered in SWITRS which is a deficiency of the system that is currently focus area of  
 4 improvement under the ongoing California Strategic Traffic Safety Data Plan (3). Given this  
 5 deficiency, it limits the ability to retrieve any further supporting information beyond the currently  
 6 available collision records in I-SWITRS.

### 8 **Injury Classification Scale and Definition of Fatal Collision**

9 Injury classification scales are based on steps representing severity levels. The most widely used  
 10 scale is known as the KABCO scale which classifies injuries into five steps:

- 11
- 12 • K – Fatal
- 13 • A – Incapacitating injury (or severe injury)
- 14 • B – Nonincapacitating injury (or minor injury)
- 15 • C – Possible injury (or complaint of pain)
- 16 • O – No injury (or property damage only)
- 17

18 The National Highway Traffic and Safety Administration’s (NHTSA) definition under the  
 19 Fatal Analysis Reporting System (FARS) requirement is that “fatal injury must only be used if  
 20 the death occurred within thirty consecutive 24-hour time periods from the time of the crash.” If  
 21 a death happens after the 30-day period, it remains listed as an injury crash and the injury is  
 22 coded as incapacitating (4). In California, similarly, a fatal collision is defined as “death as a  
 23 result of injury sustained in a collision or an injury resulting in death within 30 days of the  
 24 collision. Note: The fetus of a pregnant female involved in a traffic collision will be documented  
 25 as a fatal injury if the coroner attributes the death to the collision” according to the Collision  
 26 Investigation Manual (2008) provided by the CHP (2). Based on these definitions, injury  
 27 collisions occurring in California could actually be updated within a 30-day period, which would  
 28 result in an update in the collision database as well.

### 30 **Crash Costs for Fatal and Severe Injury Collisions**

31 A benefit cost analysis is a crucial component of data driven safety analyses. Many highway  
 32 safety improvement projects must prove the economical benefit of the proposed plan by  
 33 estimating the expected benefit compared with the costs. The various crash costs are often  
 34 applied when the expected benefit is calculated. FHWA published Crash Costs for Highway  
 35 Safety Analysis in 2018 to propose the default crash unit cost, and provided procedures to adjust  
 36 these to each state (5). Table 1 describes FHWA’s default crash costs according to the KABCO  
 37 scale. These cost figures show that an individual collision can have a huge financial impact  
 38 especially when there is a fatality involved. The comprehensive cost of a fatal collision is nearly  
 39 18 times higher than that for a severe injury collision.

41 **TABLE 1 FHWA’s Default Crash Costs by KABCO Scale**

Severity	Comprehensive Crash Unit Cost (2016 dollars)
K	\$11,295,400
A	\$655,000
B	\$198,500

C	\$125,600
O	\$11,900

The Highway Safety Improvement Program (HSIP) is a federal funding program intended to significantly reduce fatal and serious injury collisions on all public roadways. In California, HSIP funding is managed by the California Department of Transportation (Caltrans), and agencies eligible to apply for funding include city, county and tribal governments. These agencies must show data-driven potential for implementing countermeasures to reduce fatal and severe injury collisions in their locales. Caltrans determined that crash costs for fatal and severe injury collisions for HSIP applications should be assigned the same dollar value to reduce the possibility of selecting an improvement project on the basis of randomness, due to the relatively small numbers of fatal collisions (6). Table 2 describe the crash unit costs that are used for California's HSIP benefit cost analysis.

**TABLE 2 California HSIP Application Crash Costs**

Severity	Location Type	Crash Unit Cost (2018 Dollars)
Combined Fatal and Severe Injury (K + A)	Roadway	\$2,000,000
	Non Signalized Intersection	\$2,310,000
	Signalized Intersection	\$1,460,000
Evident Injury – Other Visible (B)		\$126,500
Possible Injury – Complaint of Pain (C)		\$71,900
Property Damage Only (O)		\$11,800

### Safety Performance Management

The Federal Highway Administration (FHWA) recently defined strategic goals for the Safety Performance Management (Safety PM) Final Rule that are part of an overarching Transportation Performance Management program intended to use system information for investment and policy decision making (7). The Safety PM Final Rule established the following five performance measures based on five-year rolling averages:

1. Number of Fatalities
2. Rate of Fatalities per 100 million Vehicle Miles Traveled (VMT)
3. Number of Serious Injuries
4. Rate of Serious Injuries per 100 million VMT
5. Number of Non-motorized Fatalities and Non-motorized Serious Injuries

States are now required to set specific annual targets based on these five performance measures as a part of HSIP. Maintaining the most accurate and up to date collision data information plays a pivotal role in developing competitive HSIP funding applications and helping to meet the overall Safety PM goals, which are specifically based on fatal and serious injuries. Therefore, it is crucial that government agencies have an accurate representation of the collision data from SWITRS. The purpose of this paper is to evaluate and quantify injury severity updates for data retrieved from I-SWITRS for fatal and severe injury collisions.

### METHODS

1 SWITRS data for fatal and injury collisions that occurred in 2016 were retrieved from the I-  
 2 SWITRS website for all of California at various points during 2017 and 2018. These datasets  
 3 were originally retrieved as part of quarterly updates to the Transportation Injury Mapping  
 4 System (TIMS) website maintained by the Safe Transportation Research and Education Center  
 5 (SafeTREC) at the University of California, Berkeley. Archived copies of each retrieval were  
 6 retained. A dataset retrieved on March 1st, 2017 included 193,567 fatal and injury collision  
 7 records and was determined to be an appropriate baseline dataset. This does mean that collisions  
 8 that occurred in January 2016 compared to December 2016 would have had an additional 12  
 9 months to have been edited already, but there is no public record of the number or frequency of  
 10 collisions that are edited. The decision to use this as a baseline dataset was intended to contain a  
 11 majority of the records from 2016, but not too current to prevent capturing any changes that had  
 12 yet to be made. The initial and further retrieval dates and their record counts are listed below:

- 14 • March 1, 2017 (193,567 collisions)
- 15 • June 12, 2017 (196,998 collisions)
- 16 • November 1, 2017 (197,525 collisions)
- 17 • June 22, 2018 (198,886 collisions)

18  
 19 The baseline dataset therefore contained approximately 97 percent of the final retrieval  
 20 from June 2018. For the purpose of this analysis, it was deemed an appropriate snapshot of the  
 21 data and the addition of other new records was considered inconsequential since only changes to  
 22 existing records were being evaluated.

23 The collisions were imported into an ArcGIS File Geodatabase as data tables using  
 24 ArcGIS Pro software. Fatal and injury collisions in SWITRS are categorized by increasing  
 25 severity: complaint of pain, other visible injury, severe injury, and fatal. A subset of only the  
 26 fatal and severe injury collisions was selected using the collision severity field and exported to  
 27 separate tables for each of the dated versions. The fatal and severe injury collision tables were  
 28 then joined via their unique Case ID back to the original complete datasets for all of the earlier  
 29 versions. The injury severity levels of the collisions were then compared to determine whether  
 30 there were any differences, and a list of the records that had been updated was generated.

## 31 RESULTS

32  
 33 When comparing the final version with the March 2017 baseline data, 94 injury collisions were  
 34 upgraded to fatal collisions (2.653%) and 2 fatal collisions were downgraded to severe injury  
 35 collisions (0.056%) out of the 3,543 total fatal collisions. The number of records and injury level  
 36 changes that occurred between each version and the baseline data along with the changes  
 37 between each version and the previous most recent version are shown in Table 3.

38  
 39 **TABLE 3 Overall Summary of Changes in 2016 SWITRS Data**

Data Extraction Date	Total Number of Records	Total Number of Records Difference	Cumulative Number of Records Difference	Number of Records with Injury Severity Changes	Cumulative Number of Records with Injury Severity Changes
Mar 2017	193,567	na	0	Na	0
Jun 2017	196,998	+3,431	+3,431	70	70
Nov 2017	197,525	+527	+3,958	17	87

Jun 2018	198,886	+1,361	+5,319	10	96
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The majority of the changes and newly added records occurred during the March to June 2017 timeframe. During the next year, a much smaller percentage of changes occurred as the 2016 database was more stabilized with fewer new records being added. To better understand the magnitude of the individual injury severity changes, the 96 records that were updated were categorized by their injury severity differences as shown in Table 4.

**TABLE 4 Injury Severity Changes from March 2017 to June 2018**

Original Injury Severity	Updated Injury Severity	Number of Records
Complaint of Pain	Fatal	8
Other Visible Injury	Fatal	17
Severe Injury	Fatal	69
Fatal	Severe Injury	2

In 98 percent of the cases, the updates occurred for severe injury collisions that were changed to fatal collisions, which was not unexpected. If a victim passed away after the initial collision but within the classified timeframe, that would serve as a catalyst for the record to be investigated and updated to proper injury severity when appropriate. The two fatal collisions that were downgraded to severe injury collisions were perhaps initially misclassified or the victims were determined to have passed away from natural causes before the actual collision occurred. Also notable is that there were no less severe injury collisions that were changed to severe injury collisions. This indicates that fatal collisions are understandably given a different level of scrutiny and lower injury levels are not usually re-examined after their initial input if a fatality does not occur.

For a final analysis, the 96 updated collisions were categorized according to their county and city locations and whether they were reported by the CHP or local police officers. This was done to understand the geographic distribution of the collisions and whether the location varied with the overall distributions by jurisdiction. Table 5 shows the results ordered by total number of records with changes by location. The City of Los Angeles had the highest number of changes (20 records) compared with several other locations which tied for second with 4 records, while the rate of changes based on the total reported collisions was highest (0.405%) in Compton in Los Angeles County. All unincorporated areas were CHP-reported and the vast majority of city areas were reported by the local police department. The CHP-reported collisions comprised 30 records with changes (0.036%), while the locally reported collisions contained 66 records with changes (0.057%), as summarized in Table 6.

**TABLE 5 Number of Records with Changes by Location**

County	City	Total Records	Records with Changes	Rate of Changes
Los Angeles	Los Angeles	29,732	20	0.067%
Fresno	Unincorporated	1,558	4	0.257%
Los Angeles	Unincorporated	6,613	4	0.060%
San Diego	San Diego	6,938	4	0.058%
Tulare	Unincorporated	968	3	0.310%
Los Angeles	Lancaster	1,034	3	0.290%
Riverside	Unincorporated	2,064	3	0.145%



Sacramento	Unincorporated	3,811	3	0.079%
Los Angeles	Compton	494	2	0.405%
Los Angeles	Palmdale	803	2	0.249%
Riverside	Riverside	2,109	2	0.095%
Los Angeles	Long Beach	2,302	2	0.087%
Santa Clara	San Jose	3,954	2	0.051%

NOTE: Table includes only locations with 2 or more records with changes. There were 42 locations with 1 record with changes.

**Table 6 Number of Records with Changes by Agency**

CHP Reported			Local Reported			Total		
Total Records	Records with Changes	Rate of Changes	Total Records	Records with Changes	Rate of Changes	Total Records	Records with Changes	Rate of Changes
82,627	30	0.036 %	116,259	66	0.057 %	198,886	96	0.048 %

## DISCUSSION

The 96 records that were updated represent nearly 3 percent of the total number of fatal collisions for the year, which is a significant amount given its importance to current safety performance management targets in California and state and local safety countermeasure funding programs. A single fatal collision could have a significant impact on systemic safety analyses.

The results of this analysis show that the injury severity levels of collisions available in the public California SWITRS database are, in fact, changed when necessary. There are some important considerations to keep in mind:

1. Property Damage Only (PDO) collisions were excluded from the analysis even though it is possible they could have been updated to fatal or severe injury collisions. However, they are not reported consistently statewide in California and the possible rare occurrence would not have affected the results.
2. Records were extracted at the selected intervals, but records could have been updated before or between the data extraction intervals and would not have been captured in this analysis.
3. The 2016 collision data has not yet been frozen in SWITRS by the CHP, so changes can still occur until they finalize the 2016 SWITRS data. However, this would only further increase the number of collisions that were updated.

To accommodate potential changes in the SWITRS database the TIMS website, a key data provider of georeferenced SWITRS data provides ongoing updates of provisional data. TIMS provides tools to query and map SWITRS data in a user-friendly format and is a heavily used resource outside of the I-SWITRS site. To allow the most currently available SWITRS data to be accessible, TIMS does provide provisional records for the most recent years. Users are provided with a warning message in the main query dialogs to ensure that they realize that the latest records are provisional. The provisional records are completely wiped and replaced on a quarterly basis with the latest SWITRS. Once SafeTREC receives notification from CHP that data for a specific year has been finalized, only then will a final copy be uploaded to the TIMS site and remain unchanged.

The need for current data versus the most accurate or up to date data is an ongoing tradeoff for the data provider and consumers in the state. Most users of SWITRS data are

1 reluctant or unable to wait until the data has been finalized, in order to take into account the most  
2 recent fatal and severe injury collisions for their safety analysis, possibly resulting in reducing  
3 the injury level accuracy of their databases. In fact, local agencies frequently maintain their own  
4 versions of collision data. Whether those records are accessed directly from I-SWITRS, TIMS or  
5 from local police reports, it is important to have a process in place to retroactively compare those  
6 records with the current SWITRS after data has been finalized for a particular year. This will at  
7 least ensure that the key injury severity field and potentially other fields are properly recorded  
8 and synced across the multiple data repositories that are used for data driven safety analyses.

9  
10 **The authors confirm contribution to the paper as follows: study conception and design: John**  
11 **Bigham; data collection: John Bigham, Sang Hyouk Oum; analysis and interpretation of results:**  
12 **John Bigham, Sang Hyouk Oum; draft manuscript preparation: John Bigham, Sang Hyouk Oum.**  
13 **All authors reviewed the results and approved the final version of the manuscript.**  
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