Rapid Reporting of Vehicle Crash Data in California to Understand Impacts from COVID-19 Pandemic on Traffic and Incidents

David Waetjen, Ph.D., Road Ecology Center, University of California, Davis
Fraser Shilling, Ph.D., Co-Director, Road Ecology Center, University of California, Davis

February 2021

ITS UCDAVIS INSTITUTE OF TRANSPORTATION STUDIES

Report No.: UC-ITS-2021-08 | DOI: 10.7922/G2VX0DT3

Technical Report Documentation Page

1. Report No. UC-ITS-2021-08	**2. Government Accession No.** N/A	**3. Recipient's Catalog No.** N/A
4. Title and Subtitle Rapid Reporting of Vehicle Crash Data in California to Understand Impacts from COVID-19 Pandemic on Traffic and Incidents		**5. Report Date** February 2021 **6. Performing Organization Code** ITS-Davis
7. Author(s) David Waetjen, Ph.D., https://orcid.org/0000-0001-5817-3279 Fraser Shilling, Ph.D., https://orcid.org/0000-0001-8125-2186		**8. Performing Organization Report No.** UCD-ITS-RR-20-95
9. Performing Organization Name and Address Institute of Transportation Studies, Davis 1605 Tilia Street Davis, Ca 95616		**10. Work Unit No.** N/A **11. Contract or Grant No.** UC-ITS-2021-08
12. Sponsoring Agency Name and Address The University of California Institute of Transportation Studies www.ucits.org		**13. Type of Report and Period Covered** Final Report (May 2020 – December 2020) **14. Sponsoring Agency Code** UC ITS
15. Supplementary Notes DOI:10.7922/G2VX0DT3		
16. Abstract In 2015, the Road Ecology Center at UC Davis developed a web-based method to collect all incident data that appear on the CHP real-time incident-reporting website (https://cad.chp.ca.gov/). These data are assembled into a database called CHIPS, the California Highway Incident Processing System. Previous analyses suggest that these data are more spatially accurate than other state resources (e.g., the Statewide Integrated Traffic Records System (SWITRS)). Because they are collected and organized in real-time, they can also be shared and queried more easily. The current project developed a web-portal that supports queries for counties and specific highways (https://roadecology.ucdavis.edu/resources/covid19-traffic). The results shown make apparent the reduction in crashes and traffic during the summer 2020 peak of the COVID-19 pandemic.		
17. Key Words Traffic incidents, traffic data, crash data, crash rates, databases, websites, data fusion, real time information, geospatial data		**18. Distribution Statement** No restrictions.
19. Security Classification (of this report) Unclassified	**20. Security Classification (of this page)** Unclassified	**21. No. of Pages** 15 **21. Price** N/A

Form Dot F 1700.7 (8-72) Reproduction of completed page authorized

About the UC Institute of Transportation Studies

The University of California Institute of Transportation Studies (UC ITS) is a network of faculty, research and administrative staff, and students dedicated to advancing the state of the art in transportation engineering, planning, and policy for the people of California. Established by the Legislature in 1947, ITS has branches at UC Berkeley, UC Davis, UC Irvine, and UCLA.

Acknowledgments

This study was made possible through funding received by the University of California Institute of Transportation Studies from the State of California through the Public Transportation Account and the Road Repair and Accountability Act of 2017 (Senate Bill 1). The authors would like to thank the State of California for its support of university-based research, and especially for the funding received for this project. The authors would also like to thank Kathryn Harrold for originally introducing us to the CHP incident reporting website; Drs. David Shatz and Christy Adams (UC Davis Medical Center) and Drs. Nana Tufuoh and Orion Stewart (California Department of Public Health) for their advice and input about statewide trauma reporting databases.

Disclaimer

Table of Contents

Executive Summary **1**

Introduction **4**

Approach **5**

The CHIPS Visualization Tool 5

Sample Output **6**

Future Directions and Needs **7**

References **8**

List of Figures

Figure 1. Changes in CA traffic following the statewide state of emergency and shelter-in-place (SIP) orders (state and Bay Area scale). 1

Figure 2. Sample output from the traffic condition and crash visualization tool. 3

Figure 3. Sample output from visualization tool. 6

List of Abbreviations

CHIPS	California Highway Incident Processing System
CHP	California Highway Patrol
CSV	comma separated values (a type of computer file)
PeMS	Performance Measurement System
SWITRS	Statewide Integrated Traffic Records System
UC	University of California
VMT	vehicle miles traveled

Executive Summary

Mitigation of the spread of COVID-19 has been implemented by cities, counties, and governors' offices through "shelter-in-place" and "stay-at-home" orders and related actions (e.g., closure of non-essential businesses). These orders and associated media coverage of the pandemic have resulted in a drastic reduction in vehicle travel throughout the state (Figure 1). The changes in traffic are unprecedented and their consequences largely unknown. Examining the impacts of the changes will be of critical interest to transportation and public health fields. Specific questions that should be addressed include: 1) how did rates, severity, and cost of crashes change per and post government orders, 2) do these crashes disproportionately affect certain communities, 3) where are traffic volumes and speeds still exceptionally high, and 4) how can gaps in our data collection streams be improved to understand impacts of stay-at-home orders.

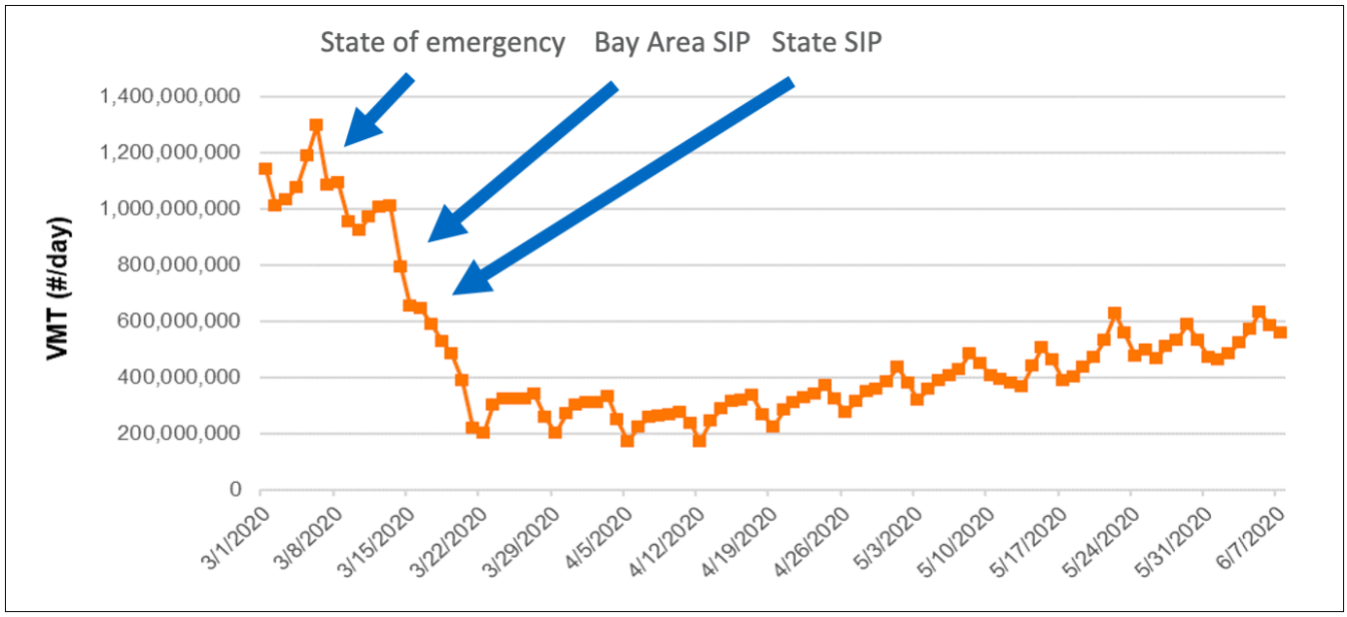

Figure 1. Changes in CA traffic following the statewide state of emergency and shelter-in-place (SIP) orders (state and Bay Area scale).

Understanding proximate causes and outcomes of traffic incidents relies on accurate data collection. The California Highway Patrol (CHP) helps to monitor, manage, and maintain safety on California roadways, and their personnel are often first to arrive at traffic incidents on highways, rural roads, and major arterials. The CHP publishes incident reports in real-time, along with information about road conditions, natural disasters, etc., on the public *CHP Traffic Incident Information Page*[1], in part so that other agencies can monitor activity in their respective regions. These data are invaluable because they capture the real-time communication between CHP officers (on the scene) and their dispatch center. Unfortunately, only a partial set of these data are available for public download, and therefore they do not represent the whole state.

[1] https://cad.chp.ca.gov/

In 2015, the Road Ecology Center at the University of California, Davis developed a web-based method to collect all incident data that appear on the CHP real-time incident-reporting website (https://cad.chp.ca.gov/). These data are assembled into a database called CHIPS, the California Highway Incident Processing System. Previous analyses suggest that these data are more spatially accurate than other state resources (e.g., the Statewide Integrated Traffic Records System (SWITRS)). Because they are collected and organized in real-time, they can also be shared and queried more easily. The current project developed a web-portal that supports queries for counties and specific highways (https://roadecology.ucdavis.edu/resources/covid19-traffic). The results shown make apparent the reduction in crashes and traffic during the summer 2020 peak of the COVID-19 pandemic.

CHIPS is a useful tool for transportation agencies and researchers because it is the most complete and accurate tool currently available to collect, manage and query incident reports for events on California state highways and other roads patrolled by the CHP. Its real-time nature and accuracy mean that it can support rapid-response assessment of events, policies and programs. During this project, the CHIPS tool was augmented with data visualization capacities to support rapid responses to events (https://roadecology.ucdavis.edu/resources/covid19-traffic). The visualization summarizes traffic at a statewide scale, a county scale, and by highway. The statewide- and county-based summaries show traffic collisions, including those with injuries and fatalities, as well as the vehicle miles traveled (VMT) per day. The summary by highway shows the frequency of traffic collision for the selected highway.

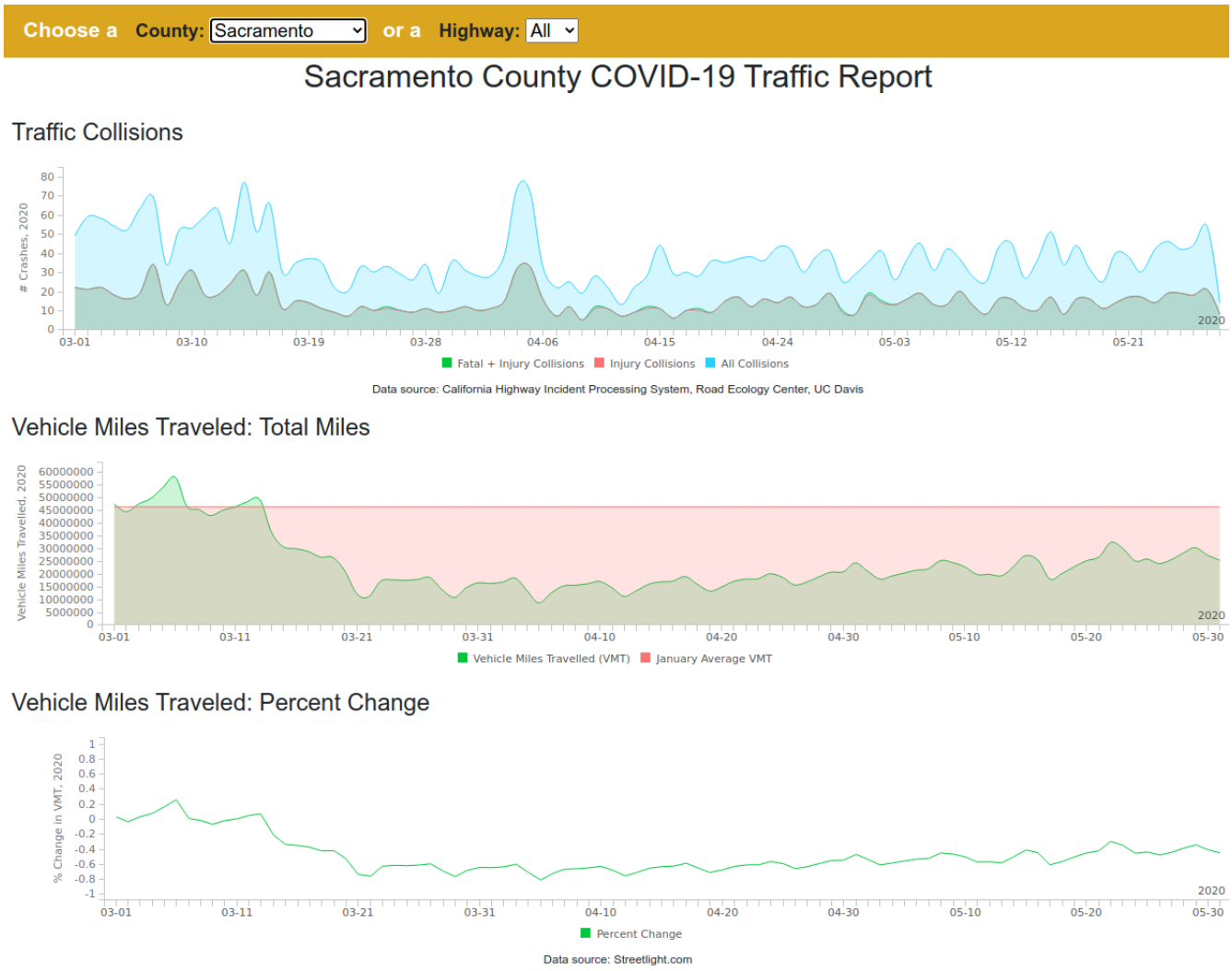

Figure 2. Sample output from the traffic condition and crash visualization tool.

Introduction

Analyzing proximal causes of traffic incidents requires accurate spatial location, temporal values, environmental conditions, involved parties, and infrastructure information (Yan et al., 2017). Automated reporting of traffic incident details is affected by legacy approaches to on-scene and post-hoc reporting of critical details, such as location, start and clear times, environmental conditions, and road curvature/slope (Bejleri and Brown, 2014). This has led to proposals to standardize data collection formats and to develop composites of incident information, including initial reporting of incident details (Santiago-Chaparro et al., 2016) and automatically managing emergency responses using shared and integrated computing services (Chen and Englund, 2018). With the advent of WAZE, a crowd-source method of reporting roadway incidents, new sources of information are becoming available that improve the rapidity and completeness of data collection about incidents both as they occur and in retrospect (Amin-Naseri et al., 2018; Young et al., 2019).

The California Highway Patrol (CHP) monitors California roadways and manages most traffic crashes and hazards on the major state and federal highways. Their incident reports tell the story of what happens on California's roads and highways. They are often first to arrive at the scene of an incident, and their narrative describes important event details and observations. The descriptions cover officers' observations and actions, and provide an accurate timeline of events. The incident location is recorded automatically for an accurate geospatial reference.

The Road Ecology Center at UC Davis has been collecting all information posted to the CHP's Incident Reporting Page since February 2015 and storing them in a local database called the California Highway Incident Processing System (CHIPS). CHIPS has collected over 4 million independent incident records since inception, and while this (currently private) database does not contain moving violations, it does include other daily CHP activities, including help following traffic collisions, traffic management (such as lane closures), natural disaster response (floods, fires), and public safety measures (during high wind or foggy conditions). All these data include CHP officer communication with their local dispatch center, who timestamp each interaction. Examples include whether an ambulance was required or not (CHP code 1141), whether there is a possible fatality (code 1144), the types of vehicles involved in the accident, and the number of lanes closed. Mining the records' textual descriptions can yield a rich set of time-series data that can be invaluable to traffic safety studies.

Caltrans publishes the CHP incident records in their Performance Measurement System (PeMS). However, when we have compared these data to CHIPS data, they appear incomplete and in some cases the data appear to be removed. Another public data source that contains California traffic accidents is the CHP published Statewide Integrated Traffic Records System (SWITRS) database. While these post-processed records provide substantial information about traffic incidents, about 1/3 lack accurate location data, and all lack narrative descriptions of the incident. Compared to both of these public systems, CHIPS is more spatially-accurate and more complete. If there were a way to integrate CHIPS and SWITRS records, then our understanding of health outcomes from traffic incidents would improve.

Approach

The CHIPS Visualization Tool

The tool's user interface was built with a combination of HTML, CSS, and Javascript. We used the BillboardJS library to produce the graphs, and jQuery to provide a more interactive experience for the user when they click on the various options. This is currently a stand-alone tool, meaning all data are self-contained and doesn't require access to a database to retrieve the data it uses. It also permits the tool to be embedded in another website, such as the Road Ecology Center's homepage.

Data Sources

There are several important sources of data used in this visualization to show change in traffic over time. The first is CHIPS, which are roadway incidents reported by the CHP as they conduct their daily business of keeping California roads safe. CHP officers enter incident details which are posted real-time to a public website. These data are collected and the number of incidents per day are counted and displayed on a graph. CHP data are available through PeMS (http://pems.dot.ca.gov) with the creation of an account.

The second data source is Streetlightdata.com, which uses cell phone movement to calculate total VMT. We compared these daily values to the average daily VMT in January 2020 to show a percent change. These data were only available to use from March 1, 2020 to May 30, 2020, which is why we limited part of the tool in this timeframe. The data are available directly from Streetlightdata.com by request.

Data Processing

These data were loaded into PostgreSQL and a set of queries created to export the data by county in a format the tool could easily read. Many of the preprocessing steps for CHIPS were done in PostgreSQL using PostGIS. We loaded the CHIPS data and state highway network spatial dataset and ran several queries and updates to determine the closest highway to each traffic incident, and made this association. We also ran a simple spatial intersection with California counties to determine within which county that incident occurred. We then ran daily summaries on both values and exported the results as CSV files, which are read by the tool. This was important in order to make the tool stand-alone, and not require access to a database to show the data. This makes the tool more efficient and easier to manage. If we want to add additional dates, we would simply need to process additional data into the proper form.

Sample Output

Beginning in March 2020, due to the COVID-19 pandemic stay-at-home orders, fewer incidents were reported by CHP across California highways due to fewer cars being on the road. With fewer cars, injury and fatal incidents and "property damage only" crashes all decreased after the shelter-at-home order was given, and then began to climb again during the summer as restrictions were lifted (Figure 3).

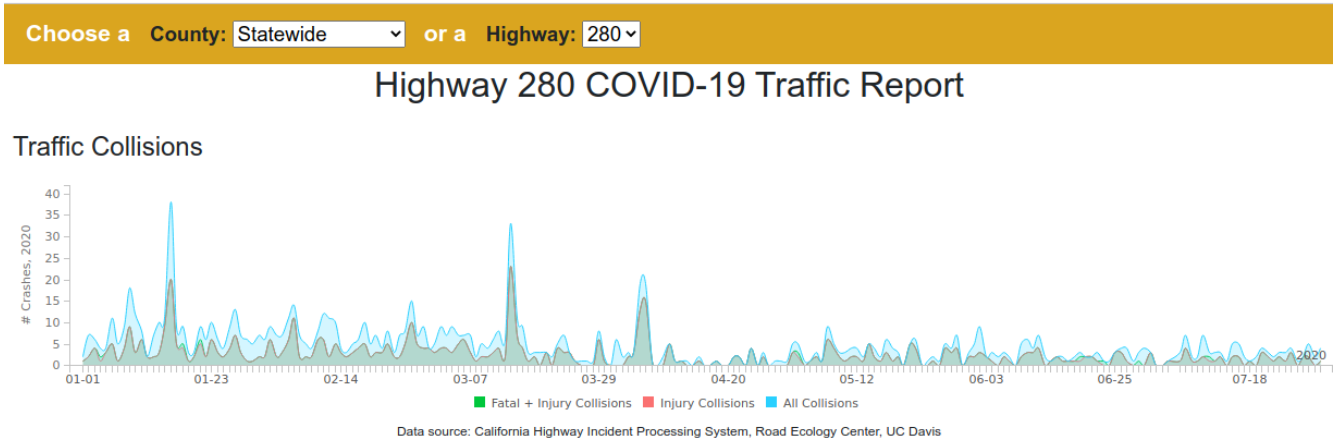

Figure 3. Sample output from visualization tool. The screenshot from the web-portal is for State Route 280, which runs from South San Francisco to San Jose. Prior to the shelter-in-place order, CHP would average over five incident reports per day, but after March 15, 2020, the daily incidents visibly dropped, with some days having zero incidents reported, which never occurred prior to the order.

Future Directions and Needs

One of the major improvements we propose to the existing system is to have the narrative details included by the CHP officer processed and made available online in real-time with tools that can help identify and "discover" incidents when a search is performed. Our current web-based database was built as a repository without keyword indexing, record discovery, or the ability for any user to conduct ad hoc queries. A key improvement we propose to the current methodology is the introduction of a pre-processing step before data are stored in a local repository. This will enable us to: 1) ensure we have the most complete information on an incident; 2) translate the descriptive details the officer provides into a series of attributes that can better classify the incident; and 3) consolidate CHP incident types into a new vocabulary which better captures the fields of interest that CHIPS data can provide (e.g., "all injury accidents", "natural disaster response").

A critical, un-met need for roadway incident reporting in California is integrating existing reporting systems, each of which contain part of the overall arc from incident to outcome. For incidents, this includes CHIPS, PeMS and SWITRS, all of which provide different benefits. Once emergency medical services (i.e., ambulances) respond, then a separate and more fragmented set of systems comes into play, with few obvious solutions. However, once individuals are received at trauma centers, then they enter a more systematic process of tracking treatments and health outcomes. These different systems potentially provide the raw materials for a complete integrated system of tracking individuals from traffic incidents to health outcomes in California, which is critical for comprehensive and accurate traffic safety analyses. Parsing these data by county or highway, or at different scales, allows for roadway managers and agencies to make fine-scale and immediate assessment of crash conditions in a way that is not currently available.

Rapid availability of traffic condition and crash data would allow for real-time assessment of local, regional or statewide policies and actions, such as stay-at-home orders. For policies that could have unintended positive or negative consequences, this real-time assessment could allow rapid feedback and adaptive management to avoid negative and encourage positive impacts. In the case of COVID-19 responses, the reduction in traffic in response to stay-at-home orders resulted in the unintended benefit of an ~50% reduction in crashes, which provided unforeseen financial and health benefits to California.

References

Amin-Naseri M., P. Chakraborty, A. Sharma, S.B. Gilbert, and M. Hong. 2018. Evaluating the Reliability, Coverage, and Added Value of Crowdsourced Traffic Incident Reports from Waze. Transportation Research Record, Vol. 2672(43) 34–43. DOI: 10.1177/0361198118790619

Bejleri, I. and Brown, D. 2014. Stretching Scarce Dollars Through Streamlined Processes and Partnerships: Prototype Implementation for a Unified, Intelligent, and Sustainable Geolocation Process for Roadway Incidents. Proceedings of the Transportation Research Board 93rd Annual Meeting. Location: Washington DC. Date: 2014-1-12 to 2014-1-16

Chen, L.; Englund, C. Every Second Counts: Integrating Edge Computing and Service Oriented Architecture for Automatic Emergency Management. J. Adv. Transp. 2018, 2018, 7592926.

Santiago-Chaparro, K.R., K. Brose, A. Bill, and D. Noyce. 2016. Improving the content of crash records: The case for a data fusion approach. Proceedings of the Transportation Research Board 95th Annual Meeting. Location: Washington DC, United States. Date: 2016-1-10 to 2016-1-14

Waetjen, D., & Shilling, F. (2020). Leveraging the California Highway Incident Processing System for Policy and Research. *UC Office of the President: University of California Institute of Transportation Studies*. http://dx.doi.org/10.7922/G2W66J27 Retrieved from https://escholarship.org/uc/item/07t6b5xj

Yan, L., Y. He, L., Qin, C. Wu, D. Zhu, and B. Ran. 2017. A Novel Feature Extraction Model for Traffic Injury Severity and Its Application to FARS Data Analysis. Proceedings of the Transportation Research Board 93rd Annual Meeting. Location: Washington DC. Date: 2017-1-8 to 2017-1-12

Young, S.D., W. Wang, B. Chakravarthy. 2019. Crowdsourced traffic data as an emerging tool to monitor car crashes. JAMA Surgery, Vol. 154(8): 777-778.