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## The Impact of California Wildfires on Patient Access to Prescription Opioids

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### Abstract

**Background:** Patients on long-term opioid therapy are particularly vulnerable to disruptions in medication access, especially during traumatic and chaotic events such as wildfires and other natural disasters.

**Objectives:** To determine if past highly destructive California wildfires were associated with disrupted access to prescription opioids for patients receiving long-term, and therefore physically dependent on, opioid medications.

**Methods:** Using California prescription drug monitoring program data, this retrospective study selected patients with long-term prescription opioid use episodes residing in ZIP code tabulation areas impacted by either the Camp Fire or Tubbs Fire. Autoregressive integrated moving average time series models were fit to pre-fire data to forecast post-fire expected values and then compared to observed post-fire data; specifically for weekly proportions of long-term episodes with early fills, late fills, changes in patients' prescriber and/or pharmacy, and fills within a different ZIP code tabulation area than the patient's residence.

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**Results:** After the Camp Fire, there were significant spikes in the proportions of early fills (peak at 56% of total, week 1 post fire), late fills (peak at 29%, week 6), and immediate significant increases in prescriber (peak at 37%, week 3) and pharmacy changes (peak at 71%, week 1) in high-impact ZIP code tabulation areas. Low-impact ZIP code tabulation areas experienced no similar disruptions. Disruptions due to the Tubbs Fire were far less severe.

**Conclusion:** Access to prescription opioids was greatly disrupted for patients living in areas most impacted by the Camp Fire. Future research should explore effectiveness of current state and federal controlled substance prescribing policies to determine what improvements are needed to minimize disruptions in medication access due to wildfires and other natural disasters.

## Background

Wildfires have always been an inherent part of the complex ecosystem of the Western United States, but the region has experienced unprecedented increases in wildfire activity in recent years. A warming climate, sustained drought, and increased development in wildland-urban interfaces all contribute to a longer and more destructive wildfire season.<sup>1,2</sup> This trend is expected to continue<sup>1,3</sup> as the climate warms<sup>4</sup> and vegetation transitions from forestlands towards grassland.<sup>5</sup> This is particularly true in California, where the last five years have seen three of the deadliest and most destructive fires in the state's history.<sup>6</sup> Two of those were the Camp Fire and the Tubbs Fire (Figure 1);<sup>7-9</sup> two historic wildfires that caused extensive structural damage, financial burden, and loss of life to populated areas in California.<sup>6</sup> The Tubbs Fire started in Napa County on October 8, 2017 and resulted in 22 deaths, 5600 structures destroyed, and billions of dollars in economic loss with the city of Santa Rosa most affected.<sup>10,11</sup> The Camp Fire started on November 8, 2018 and burned rapidly west towards the city of Chico. The fire resulted in the displacement of 50 000 evacuees and devastated the community of Paradise, causing 85 deaths, the destruction of more than 18 000 structures, and \$16.5 billion in damage.<sup>10,12,13</sup>

Wildfires are a major public health concern. Along with an array of acute<sup>14-16</sup> and long-term health challenges,<sup>10,17-19</sup> the interruption of healthcare services and subsequent exacerbations of chronic medical conditions are a primary concern.<sup>20</sup> Patients prescribed long-term opioids (>90 days continuous use) are at risk for further harms when their access to medication is disrupted. These patients generally suffer from chronic pain and have developed a physical dependence on opioids.<sup>21</sup> Without access to medication they are likely to suffer from unmanaged pain and withdrawal, and subsequently be at increased risk for overdose due to loss of tolerance and seeking nonmedical, potentially illicit, opioid sources to treat pain.<sup>21-23</sup> Therefore, maintaining continuity of care for these patients through the course of wildfire events is critical for public health, but the effect of these events on prescription opioid access is understudied.

## Objective

Using de-identified individual prescription records and area-level disaster relief data, we selected patients on long-term opioid therapy and followed them through time during two of the deadliest and most destructive wildfires in California history: the Camp and Tubbs Fires.<sup>6</sup> We analyzed trends for prescription characteristics to determine whether

disruptions in medication access were associated with these wildfires. Anticipating that sudden evacuations would lead to disruptions in medication access, we hypothesized that residents of high-impact areas would experience disruption at a far greater scale than would be seen in surrounding low-impact areas.

## Methods

### Data and Participants

De-identified, patient-level prescription data from January 1, 2014 to December 31, 2019 for all patients in California aged  $\geq 12$  were obtained from California's prescription drug monitoring program (PDMP). Data included details of all outpatient Schedule II-IV controlled substance prescriptions dispensed in the state. Prescription records for opioid analgesics were identified by linking national drug codes (NDCs) in the PDMP against a widely-available prescription drug compendium.<sup>24</sup> NDCs not identified by the compendium were manually reviewed and classified by a clinical pharmacist. Encrypted patient, prescriber, and pharmacy identifiers were included to allow tracking of these distinct entities over the study period. Prescription fill date and days' supply were used to construct distinct opioid use episodes.

Analysis was limited to long-term use episodes, defined as an opioid prescription episode more than 90 days in duration, that contained at least three opioid prescriptions, and had fewer than 60 days between the completion of one prescription and the initiation of the subsequent one. This definition, adapted from prior studies,<sup>25,26</sup> assumes that each patient receives a consistent daily dose of medication. Long-term use episodes were further categorized by patient ZIP Code Tabulation Area (ZCTA) of residence.<sup>27</sup>

Applicant-level data from the Federal Emergency Management Agency (FEMA) were used to define fire impact intensity at the ZCTA level. This publicly available de-identified dataset is updated weekly and contains records of every individual assistance application since 2002 submitted from ZIP codes where federal disaster declarations were made.<sup>28</sup> Fire-impact intensity was determined based on the number of individual applications submitted per 100 ZCTA residents. Since relatively few ZCTAs were impacted, chosen intensity cutoffs were based on observed breakpoints in the data. ZCTAs with  $>10$  applications submitted per 100 residents were considered "high-impact," while those with a lower rate that had at least one application submitted were considered "low-impact." California ZCTAs with no application filed for fire relief in the study period were used as a "no impact" comparison group. ZIP codes were linked to ZCTAs using available crosswalks<sup>29</sup> and population totals were derived from 2010 US Census data.<sup>30</sup>

### Statistical Analysis Methods

Our primary goal was to identify fire-associated disruptions of long-term opioid episodes. The analysis was conducted at the weekly level given the immediacy of the disasters. We utilized rates and proportions of patient-, prescriber-, and pharmacy-related characteristics to describe potential disruptions in prescription opioid access.

For descriptive purposes, we compared demographic estimates, based on 2013-2017 American Community Survey ZCTA-level data, and extent of fire impact, based on FEMA application data, by FEMA-based fire impact category. Also for descriptive purposes, we visually inspected time series data of patients prescribed long-term opioids, prescribers, and pharmacies in high-impact, low-impact, and comparison ZCTAs for the years prior to and following the fires' start dates. ZCTA-level estimates were aggregated into high-, low-, and comparison groups and weighted by population totals from the 2010 US Census.

Analysis focused on two types of disruptions to prescription opioid access: disruptions in supply, measured by gaps without medication supply between prescriptions, and disruptions in medication source, measured by examining changes in prescriber and/or pharmacy. Outcomes related to supply disruption were proportions of total long-term episodes with early fills (patients filling prescriptions before the runout of the previous prescription) and late fills (14-day gaps between prescription runout and the subsequent fill). Outcomes related to source disruption were proportions of long-term episode fills from a different prescriber and/or pharmacy and proportion of fills made at pharmacies located in a different ZCTA than the patient's residence.

To examine fire-associated disruptions, we forecasted post-fire expected weekly proportions for each outcome based on pre-fire data. We fit univariate auto-regressive integrated moving average (ARIMA) models to pre-fire data. ARIMA models can account for temporal auto-correlation and seasonality. The model selection process involved identifying any necessary differencing by examining observed time series data, and then determining preliminary values of the autoregressive and moving average orders.<sup>31</sup> Parameters were estimated using the PROC ARIMA procedure in SAS 9.4. Model fit was assessed using the Akaike information criterion. Model diagnostics were then examined to confirm model choice. The selected models were used to forecast expected proportions, with 95% confidence limits, and visually compared to observed post-fire data to identify fire-associated deviations from expected outcomes.

## Results

### Baseline Characteristics

We classified 3 and 11 ZCTAs as high- and low-impact areas for the Camp Fire, and 3 and 39 ZCTAs as high- and low-impact areas for the Tubbs Fire, respectively (Table 1). High-impact Camp Fire ZCTAs were less rural, had a smaller minority population, less unemployment, and lower poverty than low-impact ones. High-impact Tubbs Fire ZCTAs were also less rural, had lower income and unemployment, but had larger minority populations than low-impact ones. Data also revealed a greater impact of the Camp Fire than the Tubbs Fire on communities in affected areas. Camp Fire high-impact ZCTAs had nearly nine times the rate of homes destroyed and twice as many residents apply to FEMA for disaster relief, with five times the dollars per capita ultimately awarded, relative to Tubbs Fire high-impact ZCTAs.

## Descriptive Trends in Long-Term Opioid Prescribing Before and After Fires

Figure 2 shows trends of patients prescribed long-term opioids, prescribers for these patients, and pharmacies serving patients prescribed long term opioids for the year before and after the fire events. Low-impact areas were stable and followed similar trends to ZCTAs not impacted by these fires. Camp Fire high-impact areas, however, showed substantial changes coinciding with the week of fire occurrence. The rates of patients prescribed long-term opioids and prescribers gradually decreased and remained at a low level throughout the study period. Pharmacy activity ceased immediately after the fire and after four months recovered to only half of pre-fire levels. In contrast, Tubbs Fire high-impact areas did not experience changes in trends of patients prescribed long-term opioids while pharmacy and prescriber rates briefly dropped but returned to pre-fire levels relatively quickly.

## Disruption of Long-Term Opioid Prescribing Evident in Pre-Fire Forecast Comparisons to Observed Post-Fire Data

Disruptions of long-term opioid episodes in Camp Fire-affected areas had greater magnitude and duration than Tubbs Fire-affected areas (Figure 3). In areas highly impacted by the Camp Fire, there were marked spikes in early and late fills. The proportion of fills made early increased immediately post fire, peaked near 56% in the following week, and returned to forecasted values within 4 weeks. Late fills increased above forecasted values 4 weeks after the fire started, peaked at 29% in week 6 post fire, and did not return to expected levels for an additional 5 weeks. There were immediate increases in prescriber and pharmacy changes during the fire as well. Prescriber changes peaked at 37% in week 3 post fire and persisted above forecasted values for another 11 weeks. Increases in pharmacy changes were of a greater magnitude; peaked in week 1 post fire, at 71%, and remained above forecasted values for over 20 weeks. For the first 5 weeks post fire, every patient residing in high-impact areas filled their prescriptions in a different ZCTA than their listed residence. Throughout the year of follow-up, the proportion of fills made in different ZCTAs than the patient's residence remained far higher than forecasted values. Similar analysis of low-impact ZCTAs revealed no such disruptions.

Disruptions in Tubbs Fire high-impact ZCTAs were less than those observed in their Camp Fire counterparts (Figure 4). There was minimal disruption of the proportion of early and late fills occurring in these areas, with peaks occurring at 56% and 22% of fills, respectively. Prescriber and pharmacy changes briefly spiked (42% and 46%, respectively), but were not sustained for more than a few weeks. Patients filled more prescriptions at pharmacies in different ZCTAs than expected; levels briefly spiked post fire to 93% and remained slightly elevated relative to forecasted values throughout the year of follow-up. Tubbs Fire low-impact areas experienced brief spikes in prescriber and pharmacy changes but of a lower magnitude than those observed in high-impact areas.

## Discussion

The Camp Fire was associated with immediate disruptions in medication access for patients on long-term opioid therapy. In the week after the fire began, patients obtained refills

before their existing prescription ran out, likely because they anticipated disruptions or were replacing medication left behind when they evacuated. In the weeks that followed, a large proportion of patients were unable to obtain refills on time, with nearly four-fold increases in the proportion of fills more than 2 weeks late. The fire greatly reduced pharmacy operations in high-impact areas. For the first 5 weeks after the Camp Fire started, none of the pharmacies located in those areas were actively dispensing opioids, and patients were forced to fill prescriptions at pharmacies located elsewhere. This coincided with patients needing to identify new prescribers at much higher rates than before the fire.

Though disruptions were observed after the Tubbs Fire, the magnitude of these disruptions was far smaller and of shorter duration than was observed after the Camp Fire. One likely explanation for this difference is the greater scale of devastation caused by the Camp Fire. The Camp Fire resulted in the destruction of entire communities, most notably the town of Paradise, with nearly four times as much structural damage and loss of life than the Tubbs Fire.<sup>11,12</sup> Dry winds, local geography, and a high load of dry vegetative fuel led to the rapid growth and spread of the fire giving local residents little warning and forcing immediate evacuations.<sup>13</sup> The speed and urgency of these evacuations, coupled with the large totals of people evacuating, likely led to large amounts of medications left behind, precipitating a need for evacuees to fill new prescriptions and contributing to the observed large spike in early fills.

These findings carry public health implications. Patients on long-term opioid therapy are at risk for further harm when their therapy is disrupted, including withdrawal, deteriorating mental and physical health, transitions to illicit opioids, and overdose.<sup>21,22</sup> Risk for these harms is exacerbated by fire-associated traumas, such as physical injury and emotional trauma due to the evacuation and possible loss of dwelling, property, and employment. Additionally, desperate patients unable to fill prescriptions may attempt to acquire them non-medically (e.g., diversion) to avoid withdrawal. This behavior carries substantial risk of overdose given the recent flood of fentanyl-containing counterfeit prescription pills into the United States.<sup>32</sup> That risk increases as patients go without opioids for extended periods and lose tolerance.<sup>23</sup>

How local pharmacies reacted to the sudden influx of evacuees who needed medication provides critical context for understanding observed disruptions in patient access to medication. In 1996, California adopted legislation relaxing requirements for dispensing controlled substances in areas with a state of emergency declaration. These laws allow for the furnishing of drugs without a prescription, including refills and new prescriptions of “reasonable amounts,” as long as the dispensing pharmacist documents the emergency refill and attempts to notify the patient’s prescriber. The law also provides for the operation of mobile pharmacies in impacted areas.<sup>33</sup> In the case of both fires, the Governor quickly declared a state of emergency, the day of the Camp Fire<sup>34</sup> and the day after the Tubbs Fire,<sup>35</sup> thus relaxing restrictions on dispensing prescription medications to those affected. Despite these declarations, there were still a large portion of patients prescribed long-term opioids who did not receive their prescriptions in a timely fashion, as nearly 30% of fills 6 weeks after the Camp Fire ignition were filled late (four times the expected proportion of 7.5%).



A California Pharmacy Board Licensing Committee report highlighted a number of obstacles to serving patients in need during the Camp Fire, including patients not having the means to cover copays, lack of knowledge of emergency dispensing statutes, dispensing pharmacists choosing not to follow them due to fears over violations, and corporate and third-party payer obstacles.<sup>36</sup> The influx of early fills coupled with delayed increases in late fills may indicate scenarios where patients were able to obtain short supplies in the immediate wake of the fire but struggled to maintain access in the following weeks. When confronted with a disaster event as destructive as the Camp Fire, the law appears to have been more effective at dampening initial disruptions but less so at maintaining long-term continuity of care. After the Camp Fire, the California Pharmacy Board took measures to improve access to controlled substances.<sup>36</sup> Notably, an amendment was introduced in early 2020 further relaxing paperwork requirements for dispensing controlled substances;<sup>37</sup> the extent to which this change may have reduced disruptions in subsequent wildfires remains unknown.

Future disaster relief efforts can be improved to minimize patient loss of access to their prescription medication. Outreach to patients, prescribers, and pharmacists, especially in evacuation camps, is imperative to ensure these groups are clear on how regulations, and prescription medication access, change during these events. Patients unaware of relaxed regulations may not go to pharmacies to receive medication while uneasy pharmacists may remain hesitant to furnish opioids, particularly longer day's supply of Schedule II substances, to patients without a prescription. Though highlighted as an issue in the wake of the Camp Fire,<sup>36</sup> it is unclear what measures have been taken to improve the communication of emergency dispensing statutes to these groups. Furthermore, creation of a disaster response team tasked with the identification of evacuees in immediate need of prescription medications would greatly increase the effectiveness of existing legislation; by not only guiding displaced patients to acquire their medications, but also assuring pharmacists that medications dispensed in this manner are done so responsibly and legally. Existing disaster-response resources at the federal level could serve as a model for such a task force in the state.<sup>38</sup>

To our knowledge, this study is the first to examine disaster-related disruptions to patient access to prescription opioids. This study does have limitations. De-identified PDMP data is only available at the ZIP code level, which made it impossible to parse out smaller communities within each ZIP code that may have been differentially impacted by the fires. Additionally, our definitions for categorizing ZCTAs into fire impact areas were ad hoc. We are, to our knowledge, the first to attempt to use FEMA application data in this manner. Nevertheless, our definitions did capture clear differences in our outcomes between high- and low-impact areas.

## Conclusion

Analysis of PDMP records revealed substantial disruptions in patient access to opioid analgesics in the wake of the Camp Fire. Patients scrambled to find new prescribers and/or pharmacies to maintain their medication supply and in some cases were more than two weeks late in receiving their medication. These disruptions are particularly concerning given



recent trends of worsening wildfires throughout California and the Western United States. It is unknown what role existing policy played in patient access to opioid analgesics as our study was not meant to conduct such an evaluation. Future research to examine prescriber and pharmacist attitude to policy and explore possible improvements to current protocols to minimize disruptions in medication access is warranted.

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### Key Points

#### What was already known

- Wildfires and other disaster events greatly disrupt the lives of the people impacted by them.
- Patients on long-term opioid therapy are especially vulnerable to disruptions in medication access.
- The impact of wildfires and other natural disasters on continued access to opioid medications is understudied.

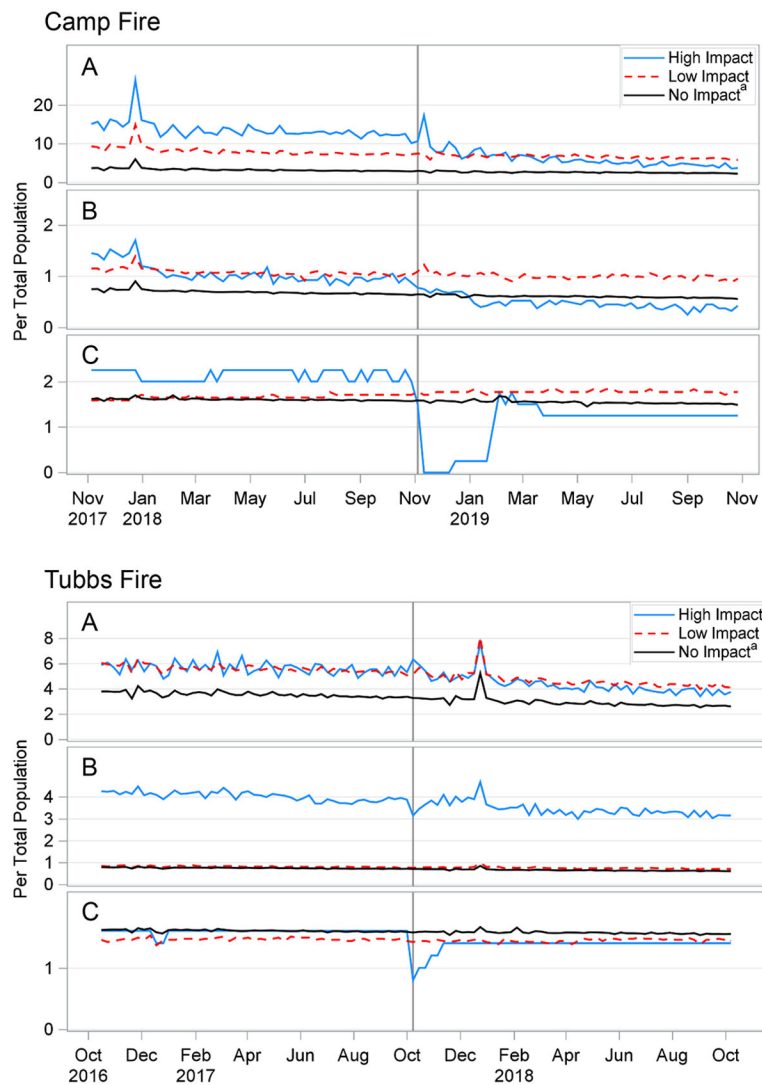
#### What this study adds

- The Camp Fire was associated with substantial disruptions in prescription opioid access; including an immediate spike in prescriptions filled early, a substantial increase in late (>14 days) prescriptions in the weeks that followed, and sustained prescriber and pharmacy disruptions.
- Continued access to opioid medications is critical for patients prescribed in the long-term, and current policies need to be evaluated to ensure disruptions to medication access during wildfire events is minimized.



**Figure 1: Map of Camp Fire and Tubbs Fire Perimeters**

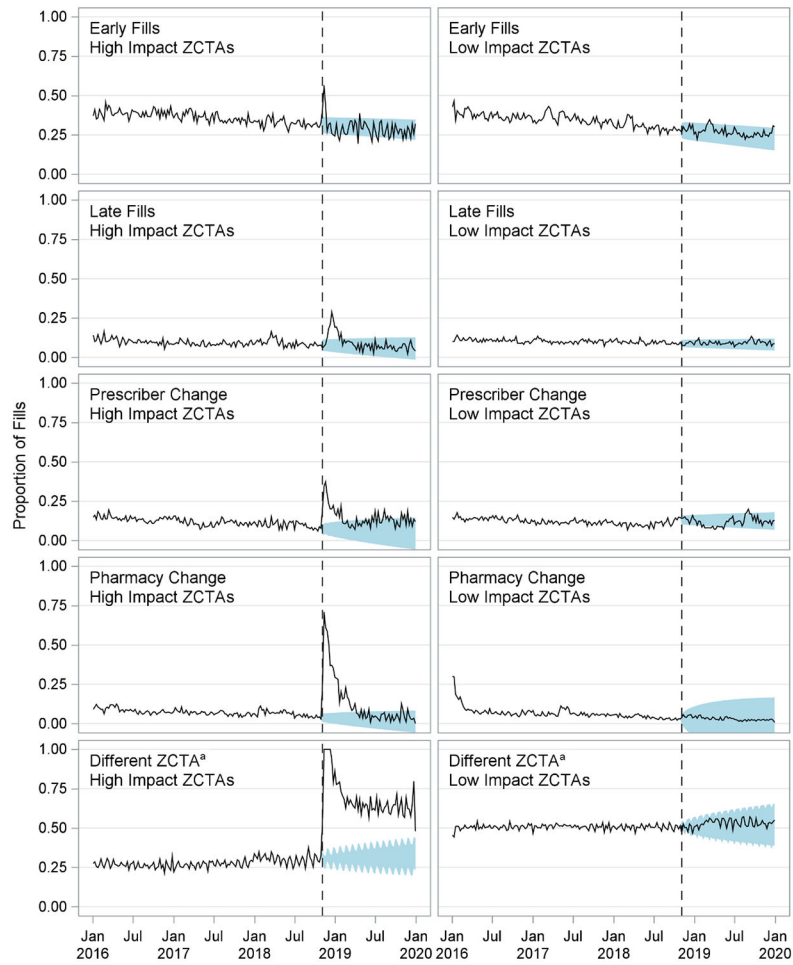
The approximate location and size of the wildfires analyzed in this study. The Tubbs Fire started in Napa County on October 8, 2017. The Camp Fire started on November 8, 2018 in Butte County. This map was generated from publicly available map files supported and maintained by the Environmental Systems Research Institute (ESRI).<sup>7-9</sup>



**Figure 2. Pre- and post-fire patients on, pharmacies dispensing, and prescribers of long-term opioids by fire-impacted ZCTAs.**

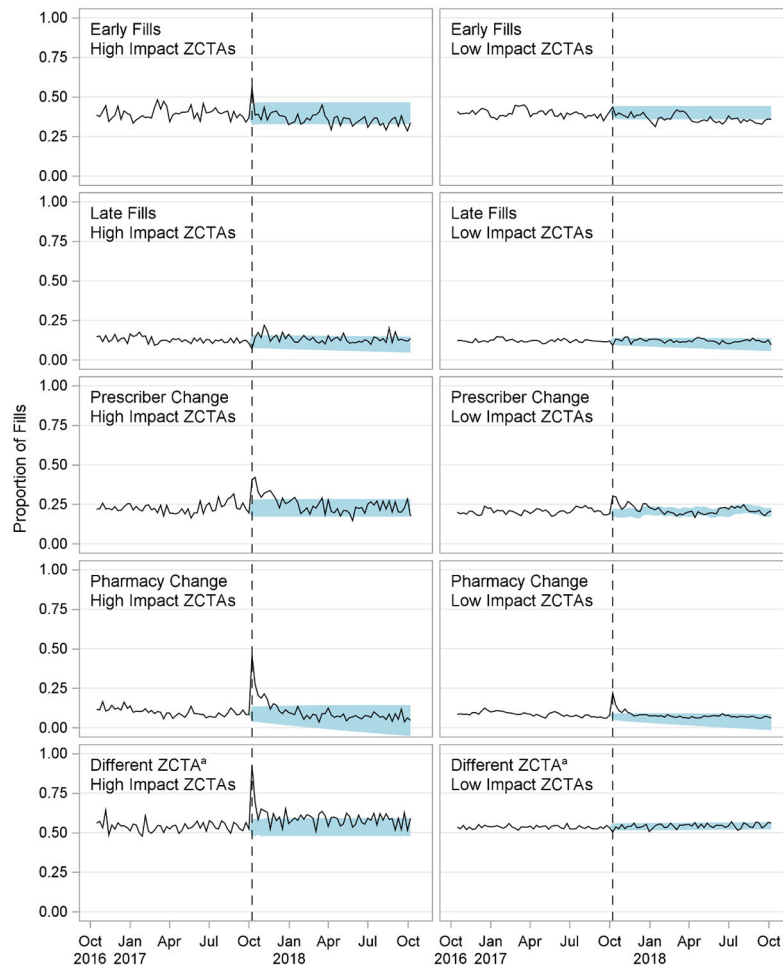
<sup>a</sup>Includes all ZCTAs not defined as either high or low impact for either the Tubbs or Camp Fires

Plot includes observed weekly time series of (A) patients prescribed long-term opioids, (B) prescribers writing prescriptions for patients prescribed long-term opioids, and (C) pharmacies filling prescriptions to patients prescribed long-term opioids for the year before and after the individual fires (denoted by the solid vertical line) by fire impact. Fire impact was determined based on individual FEMA applications submitted per 100 ZCTA residents. ZCTA population based on the 2010 Census data totals.



**Figure 3. Camp Fire ARIMA forecast of expected versus observed weekly proportions.**  
<sup>a</sup>Prescription filled at a pharmacy with a different ZCTA than patient residence  
 Observed data (solid line) compared to expected data forecasted using ARIMA models for Camp Fire impacted ZCTAs. The shaded areas indicate expected values with 95% confidence. The dashed vertical line indicates the week of fire ignition.





**Figure 4. Tubbs Fire ARIMA forecast of expected versus observed weekly proportions.**  
<sup>a</sup>Prescription filled at a pharmacy with a different ZCTA than patient residence  
 Observed data (solid line) compared to expected data forecasted using ARIMA models for Tubbs Fire impacted ZCTAs. The shaded areas indicate expected values with 95% confidence. The dashed vertical line indicates the week of fire ignition.

**Table 1:**Characteristics of ZIP Code Tabulation Areas (ZCTA) by Fire Impact<sup>a</sup>

|   | Camp Fire                |                          | Tubbs Fire               |                          | No Fire                            |
|---|--------------------------|--------------------------|--------------------------|--------------------------|------------------------------------|
|   | High Impact<br>(ZCTAs=3) | Low Impact<br>(ZCTAs=11) | High Impact<br>(ZCTAs=3) | Low Impact<br>(ZCTAs=39) | Rest of California<br>(ZCTAs=1705) |
| Demographics <sup>b,c</sup>   |                          |                          |                          |                          |                                    |
| Total Population <sup>d</sup>                                       | 39 943                   | 178 292                  | 49 735                   | 575 366                  | 36 406 128                         |
| Median Household Income (Dollars), mean (SD)                        | 47 517 (3670)            | 47 362 (9909)            | 69 934 (5361)            | 74 503 (11 639)          | 71 284 (29 272)                    |
| Percent Adults with High School Diploma, mean (SD)                  | 91.2 (0.6)               | 88.2 (6.4)               | 86.0 (4.7)               | 86.9 (6.4)               | 81.4 (13.5)                        |
| Percent Households under 150% Poverty Line, mean (SD)               | 26.2 (4.5)               | 33.1 (7.2)               | 17.7 (2.4)               | 17.6 (5.5)               | 25.0 (13.0)                        |
| Percent Adults Unemployed, mean (SD)                                | 8.3 (0.7)                | 9.4 (2.6)                | 4.7 (1.5)                | 5.9 (1.9)                | 7.9 (3.2)                          |
| Percent Population White, mean (SD)                                 | 87.5 (2.1)               | 69.8 (7.9)               | 57.7 (10.9)              | 62.2 (14.9)              | 37.3 (23.6)                        |
| Percent Population Living in Urban Areas, mean (SD)                 | 86.9 (10.7)              | 79.9 (23.4)              | 94.0 (14.7)              | 86.9 (16.5)              | 95.2 (15.0)                        |
| Fire Damage <sup>b,d,e</sup>  |                          |                          |                          |                          |                                    |
| Claim Applications per 100 Residents, mean (SD)                     | 51.7 (10.3)              | 1.3 (2.2)                | 14.5 (2.8)               | 2.1 (2.1)                |                                    |
| Destroyed Homes per 100 Households, mean (SD)                       | 41.4 (17.1)              | 0.9 (2.1)                | 4.8 (0.5)                | 0.2 (0.5)                |                                    |
| Amount Approved for Disaster Relief (Dollars per Capita), mean (SD) | 1876 (876)               | 59 (139)                 | 164 (34)                 | 7 (15)                   |                                    |

<sup>a</sup>Fire categories defined based on rate of applications for relief made to the Federal Emergency Management Agency (FEMA) Individuals and Households Program and derived from those data. Definitions are as follows: high impact, ZCTAs with >10 applications per 100 residents; low impact, ZCTAs with 10 applications and at least one application submitted

<sup>b</sup>Means and standard deviations weighted by ZCTA population totals derived from 2010 US Census Data

<sup>c</sup>ZCTA demographic estimates derived from 2013-2017 American Community Survey Data

<sup>d</sup>ZCTA population and household totals derived from 2010 US Census Data

<sup>e</sup>Derived from Federal Emergency Management Agency Individuals and Households Program Application Data