



A REPORT TO THE INDUSTRY

**The Impact of Declining Opioid Use
on
Lost-Time Claim Development &
Outcomes in California
Workers' Compensation**

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INTRODUCTION

The opioid epidemic is a well-documented public health concern. In terms of workers' compensation, research studies have shown that prolonged opioid use is associated with both delayed recovery from workplace injuries¹ and increased medical costs.²

The workers' compensation industry has responded to the crisis with a multitude of policy and medical management interventions, including increased application of evidence-based medicine treatment and pain management guidelines, drug formularies, prescription drug monitoring programs (PDMPs), and targeted law enforcement against "pill mills." In addition, several state attorneys general and county district attorneys have brought class action lawsuits against opioid manufacturers seeking and securing financial penalties for deceptive marketing practices. These interventions have been instrumental in fueling the decline in opioid use in California workers' compensation as well as workers' compensation programs in other jurisdictions.^{3,4}

Opioid use in the California system hit a high-water mark in accident year 2008, when opioids were dispensed in 50 percent of all lost-time claims. Since then, opioid use in the system has been in a downtrend, declining to just 26 percent of accident year 2017 lost-time claims.⁵ Whether this trend continues will depend on medical practice patterns and continued public awareness of the consequences of excessive opioid use.

Over the past two decades, several studies have measured changes in the level of opioid use, the association between opioid use and adverse health outcomes, and delays in return to work. At the same time, however, there has been limited research on the association between declining opioid use and reductions in workers' compensation costs and lost work days.

To help fill that void, this study uses data from California workers' compensation lost-time claims in which treatment was initiated between 2008 and 2017 to answer the following three questions:

1. What are the trends in both the frequency and intensity of claims with acute and chronic opioid use?
2. To what extent has decreased opioid use driven changes in medical and indemnity cost trends?
3. What is the impact of declining opioid use on benefit payments, TD days, and systemwide costs?

¹ Savych, B., Neumark, D., and Lea, R. The Impact of Opioid Prescriptions on Duration of Temporary Disability. Cambridge, MA: Workers Compensation Research Institute, March 2018 (www.wcrinet.org).

² Swedlow, A., Gardner, L., Ireland, J., Genovese, E. Pain Management and the Use of Opioids in the Treatment of Back Conditions in the California Workers' Compensation System. A Report to the Industry. CWCI, July 2008.

³ Hayes, S., Swedlow, A. California Workers' Comp Pharmaceutical Utilization & Reimbursement, Part 2: Emerging Outcomes Under the MTUS Formulary. CWCI Spotlight Report, March 2019.

⁴ Thumula, V., Wang, D., Liu, T-C. Interstate Variations in Dispensing Opioids, 5th Edition. Cambridge, MA: Workers Compensation Research Institute, July 2019 (www.wcrinet.org).

⁵ Source: CWCI Industry Research Information System (IRIS) valued through December 2018.

EXECUTIVE SUMMARY

A growing body of medical literature and popular press articles documents the public health and economic costs of the nationwide opioid epidemic over the past decade. The associated public policy research studies, statutory⁶ and regulatory changes, and increased public awareness have contributed to a reduction in opioid use in the California workers' compensation system. This study quantifies the declining prevalence of opioids in the system and estimates the impact of that decline on average benefit payments per lost-time claim, the average number of paid temporary disability (TD) days, and overall costs within the California workers' compensation system.

Using a database of 273,106 workers' compensation lost-time claims in which treatment was initiated from 2008 through 2017, with payment and prescription data through 2018, the authors found that:

- The proportion of injured workers receiving opioids declined by 51 percent, from 49 to 24 percent over the study period.
- The prevalence of claims with chronic opioid use (defined as receiving three or more opioid prescriptions within four consecutive months) declined by 77 percent, from 13 to 3 percent; those with acute use (i.e., all other opioid use) declined by 40 percent, from about 36 percent to just over 21 percent.
- The 51 percent decline in the proportion of injured workers receiving opioids partially offset the increases in average benefit payments on lost-time claims with and without opioid use, which increased by 11 percent and 50 percent respectively over the 10-year span of the study.

Regression models were employed to isolate the impact of opioids from other known cost drivers of benefit payments and lost time from work at various stages of claim development. Comparing lost-time claims for the same type of injury with and without opioid use at 12 months and 120 months (10 years) showed:

- Average benefit payments were 29.7 percent less for claims without opioid use than for claims with opioids at 12 months and 37.0 percent less at 120 months.
- Claims without opioid use had 25.2 percent fewer TD days than claims with opioid use at 12 months, and 30.2 percent fewer TD days at 120 months.
- Average benefit payments at 12 months on claims with acute opioid use were 28.1 percent less than those on claims with chronic opioid use, while average benefits at 120 months were 35.9 percent less.
- Acute opioid use claims averaged 27.6 percent fewer TD days at 12 months than chronic opioid use claims, and 31.3 percent fewer TD days at 120 months.
- Systemwide savings from the decline in opioid use are projected to reach 16.5 percent for 2017 claims at 10 years of development.
- Cumulative savings from the decline in opioids are projected at \$6.5 billion for 2010-2017 claims.

⁶SB 863 (Statutes of 2012, Chapter 363) IMR effective 07/01/13 for all dates of injury; and AB 1124 (Statutes of 2015, Chapter 525, Chapter 25) MTUS Formulary effective 01/01/18 for all dates of injury.

STUDY DATA AND METHODS

Study Data

This study is an analysis of data from 273,106 California workers' compensation lost-time claims with dates of first medical treatment ranging from January 1, 2008 through December 31, 2017, and with payments through December 31, 2018. This time period includes the high point in opioid use (2008) through the downtrend observed in recent years. Data was compiled from the CWCI Industry Research Information System (IRIS).⁷ Claim payments and indicators of opioid use were tracked by year, for up to ten years, and by the number of months of claim development, measured from the date of first treatment.

Studies of workers' compensation claims generally track payments by accident year. However, for a growing number of California's cumulative trauma claims⁸ there is a significant delay from the reported date of injury (which is sometimes estimated) to the date of the first medical treatment.⁹ To get a more accurate measurement of the relationship between opioid use and claim outcomes at various stages of treatment, the first treatment date was used as the starting point for each of the claim development benchmarks in the study.

The data in this study is limited to opioid use in the workers' compensation system, so any use of opioids outside the system is not accounted for in the study.

The methods used to examine the three study questions are described below.

Methods

Question 1: What are the trends in both the frequency and intensity of claims with acute and chronic opioid use?

In order to study the changing pattern of opioid use within the population of injured workers, we examined a variety of utilization measures. These were stratified by year of first treatment and by the age of the claim, measured in months of development from the first treatment date. The utilization measures included:

- **Percentage of claims with opioids.** The number of claims with at least one opioid prescription as a proportion of all claims.
- **Prescriptions per opioid user.** The ratio of prescriptions filled divided by the number of opioid users, regardless of the number of doses or strength of each dose.
- **Morphine Milligram Equivalents (MMEs) per opioid prescription.** The average amount of drug agent in each prescription. This amount is calculated by multiplying the number of units (e.g., tablets or capsules) by the drug strength and its MME conversion factor.¹⁰ This adjusts for differences in potency, making it possible to include all types of opioids in the calculation.

⁷ IRIS is CWCI's proprietary transactional database of California workers' compensation claims comprised of approximately 65 percent of the insurer market as well as self-insured employers.

⁸ The World of Cumulative Trauma Claims: (https://www.wcirb.com/sites/default/files/documents/the_world_of_cumulative_traum_claims_study_102018.pdf) WCIRB, 2018.

⁹ Jones, S., David, R., Hayes, S. Cumulative Trauma in California Workers' Compensation. CWCI Research Note, December 2016.

¹⁰ Calculating Total Daily Dose of Opioids For Safer Dosage, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. (https://www.cdc.gov/drugoverdose/pdf/calculating_total_daily_dose-a.pdf)

- **Morphine milligram equivalents (MMEs) per opioid user.** The sum of MMEs across all prescriptions per opioid user (i.e., the product of the previous two measures).
- **Claim Closure.** The proportion of closed claims within each development time frame.

In addition to comparing opioid claims to non-opioid claims, the study also compared two subgroups: acute opioid use claims and chronic opioid use claims. For this study, chronic opioid use was defined based on the CDC's definition of chronic pain, as described in the *CDC Guideline for Prescribing Opioids for Chronic Pain*. This document states: "Chronic pain has been variably defined, but is defined within this guideline as pain that typically lasts >3 months or past the time of normal tissue healing."¹¹ Thus, within this study, we identified chronic opioid use claims as those that had three or more opioid prescriptions, each filled at least three weeks apart, and all filled within a period of four consecutive months.

Question 2: To what extent has decreased opioid use driven changes in medical and indemnity cost trends?

This analysis explored the relationship between trends in opioid utilization and that of the broader California workers' compensation population. It also illustrated how this data might be used to refine projections of benefit payments across all claims.

Claim triangles¹² were developed in order to project medical and indemnity payments from the valuation date (December 31, 2018) to a maturity level of ten years from the date of first treatment. Each claim triangle contained the following information:

- Age of the claim (from three to 120 months)
- Year of the first medical treatment of the claim (from 2008 to 2017)
- Cumulative claim payments (by age and year of first service)

Factors representing payment growth from one stage of development to the next (e.g., 12 months to 24 months) were used as the basis for projecting the payments. These projections were developed separately for medical and indemnity payments, and for each of the following subgroups of claims:

- Claims with acute opioid use
- Claims with chronic opioid use
- Claims without opioid use

Thus, the resulting projections were not influenced by shifts in the distribution of acute, chronic, and non-opioid claims within the study groups.

Question 3: What is the impact of declining opioid use on benefit payments, TD days, and systemwide costs?

To address this research question, the authors used regression analysis to estimate the association between opioid use and claim outcomes, while controlling for other variables that are also correlated with claim outcomes. These estimates were used to project the medical and indemnity costs that would

¹¹ Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report, CDC Guideline for Prescribing Opioids for Chronic Pain — United States, 2016, Recommendations and Reports / March 18, 2016 / 65(1);1–49.

¹² For purposes of this study, medical and indemnity payments were cross tabulated by year of first medical service and by claim age, relative to the date of first medical service. Because more recent claims have less history than older claims, those year/age combinations in the cross tabulation are left blank, which forms a triangle. (See Appendices 1 and 2.)

have been incurred if the opioid use trend had continued its trajectory from the baseline period (2008/2009). The baseline figures were compared to the projected benefits associated with the lower levels of opioid use noted for AY 2010 through 2017 to estimate the savings attributable to the declining use of opioids.

A separate regression model was developed for each key explanatory variable (opioid use versus non-opioid use, and chronic versus acute opioid use) and outcome measure (total paid medical/indemnity benefits and TD days) at 10 development periods (from 12 through 120 months), for a total of 40 models. The models controlled for five categories of risk factors:

- **Worker/Job Characteristics:** age/gender, region, industry, tenure, and employer size
- **Medical Diagnosis:** primary diagnosis and comorbidities
- **Injury Characteristics:** nature of injury, cause of injury, and body part
- **Treatment Characteristics:** inpatient hospitalization
- **Administrative Process-Related Factors:** attorney involvement, days from injury to first medical service, days from injury to carrier notification, and claim type (TD or PD).

The unit of observation was an individual claim for an injured worker. Each claim record included benefit payments and TD days at various stages of development, and a set of binary values indicating the presence or absence of each independent variable (risk factor). Any independent variable that was not significant at the $p < 0.05$ level was excluded from that particular model.¹³ The regression models also accounted for the skewed shape of the distributions of the dependent variables (benefits paid and TD days).¹⁴

¹³ In statistical analysis, probability values (p -values) measure the probability of obtaining test results at least as extreme as the results actually observed.

¹⁴ The models used a gamma distribution with a log link function because it approximates the skewed shape of the distributions of the dependent variables.

FINDINGS

Question 1: What are the trends in both the frequency and intensity of claims with acute and chronic opioid use?

Exhibit 1 shows the proportion of claims that had one or more opioid prescriptions within the first year of development. The percentage of claims in which opioids were dispensed within 12 months of the initial treatment fell from 49 percent in 2008 to 24 percent in 2017, a relative decline of 51 percent over that 10-year period.

Exhibit 1: Percent of Claims With and Without Opioid Use Within 12 Months of First Treatment

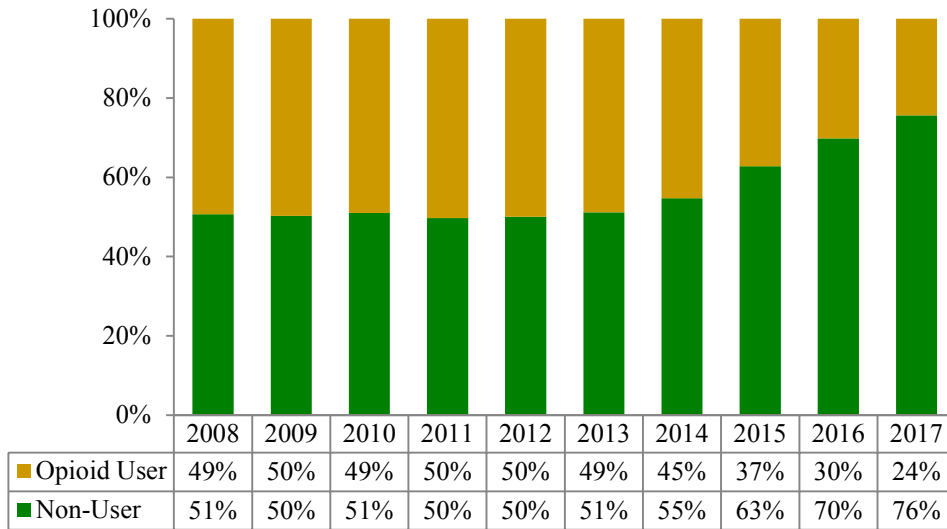


Exhibit 2 shows the speed of opioid adoption on claims. In more than 90 percent of all claims with opioids, the initial opioid prescription was dispensed within the first nine months of claim development.

Exhibit 2: Percent of Opioid Claims: Time from First Treatment to Initiation of Opioid Use

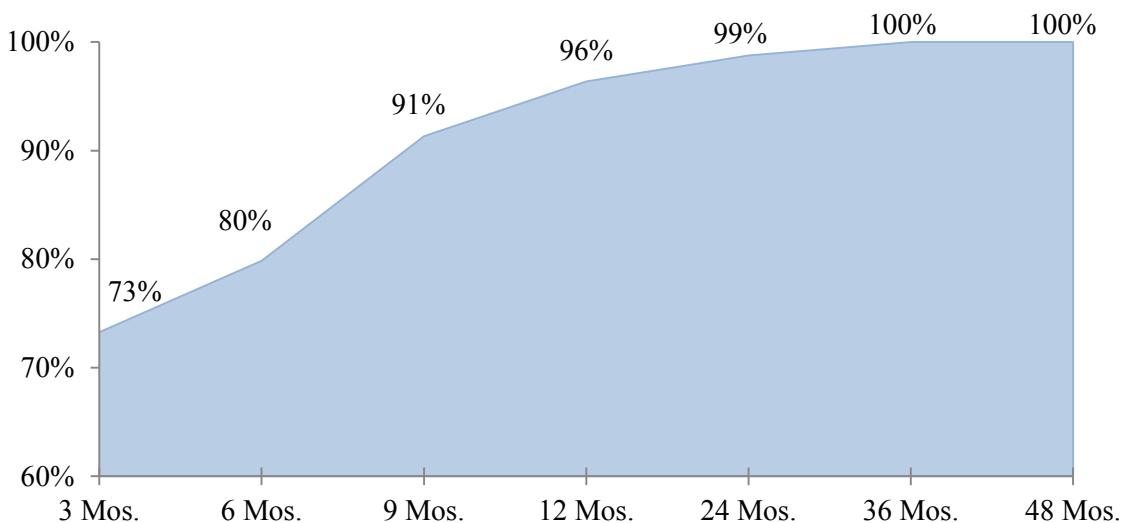
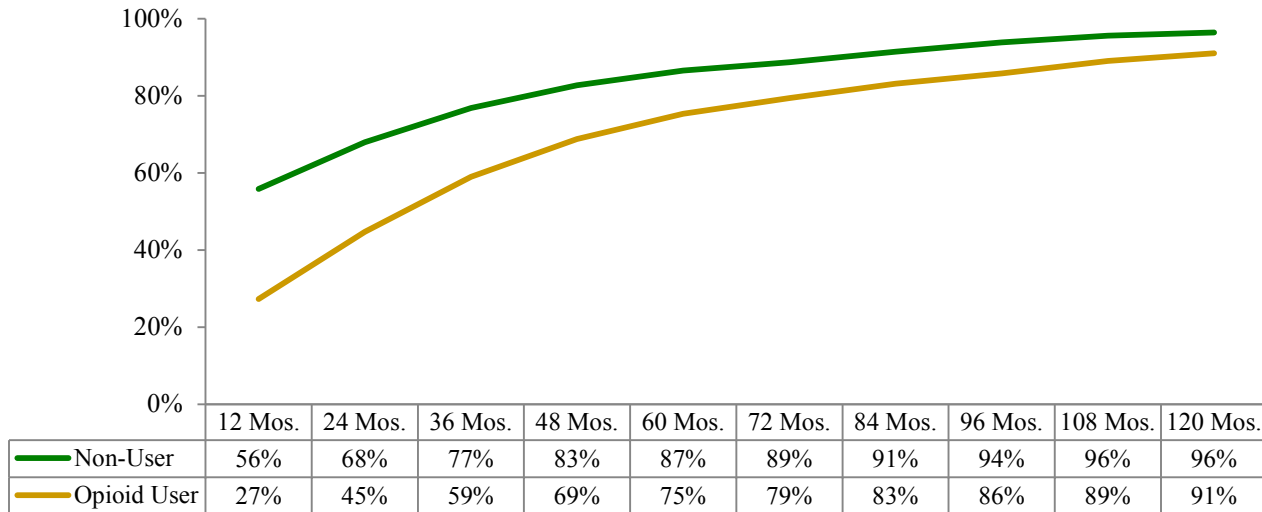


Exhibit 3 compares claim closures for opioid users to those of non-users and reveals that opioid claims remained open much longer than non-opioid claims. For example, approximately two-thirds of all non-opioid claims (68 percent) were closed within 24 months of development. However, it wasn't until 48 months of development that opioid claims reached a similar closure rate (69 percent).

Exhibit 3: Opioid User and Non-User Claim Closure Rate as a Percentage of 10-Year Closure Rate by Month of Development



Exhibits 4 through 7 show specific changes in chronic and acute opioid use from 2008 to 2017. As noted earlier, claims with three or more opioid prescriptions, each filled at least three weeks apart, and all filled within four consecutive months were deemed chronic opioid use claims, while acute opioid use claims were those with at least one opioid prescription but less than the chronic use thresholds.

Exhibits 4 and 5 display frequency of claims with chronic and acute opioid use and average number of prescriptions per claim. Exhibit 4 shows that both chronic and acute opioid use claims experienced sharp declines over the 10-year study period. On a relative percentage basis, claims with chronic and acute use of opioids fell by 77 percent (13% to 3%) and 40 percent (36% to 21%) respectively.

Exhibit 4: Percent of Claims with Chronic and Acute Opioid Use at 12 Months by Year of First Treatment

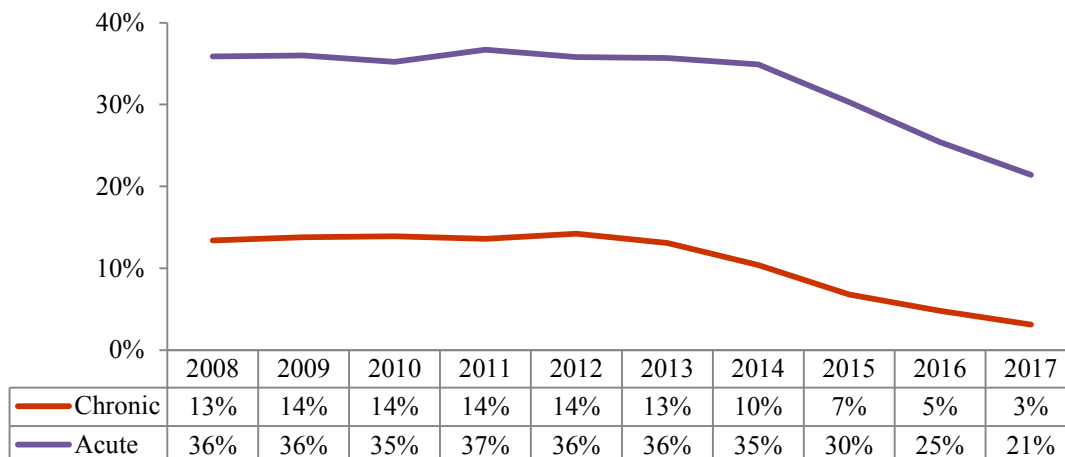


Exhibit 5 reveals that the average number of opioid prescriptions per claim declined by 43 percent for chronic users (11.5 to 6.5) and 23 percent for acute users (2.2 to 1.7).

Exhibit 5: Opioid Prescriptions per Claim at 12 Months by Year of First Treatment – Chronic & Acute Use



Exhibits 6 and 7 show the changes in the strength or potency of opioids for chronic and acute use as expressed in MMEs.

Exhibit 6 shows a 10-year downtrend in average MMEs per prescription for chronic (-27%) and acute (-17%) opioid use claims during the first 12 months following first treatment. This reduction in the average strength per opioid prescription, combined with the decreasing number of prescriptions per claim, led to a sharp drop in total MMEs dispensed per claim.

Exhibit 6: Average Strength (MMEs) Per Opioid Prescription at 12 Months by Year of First Treatment - Chronic & Acute Use

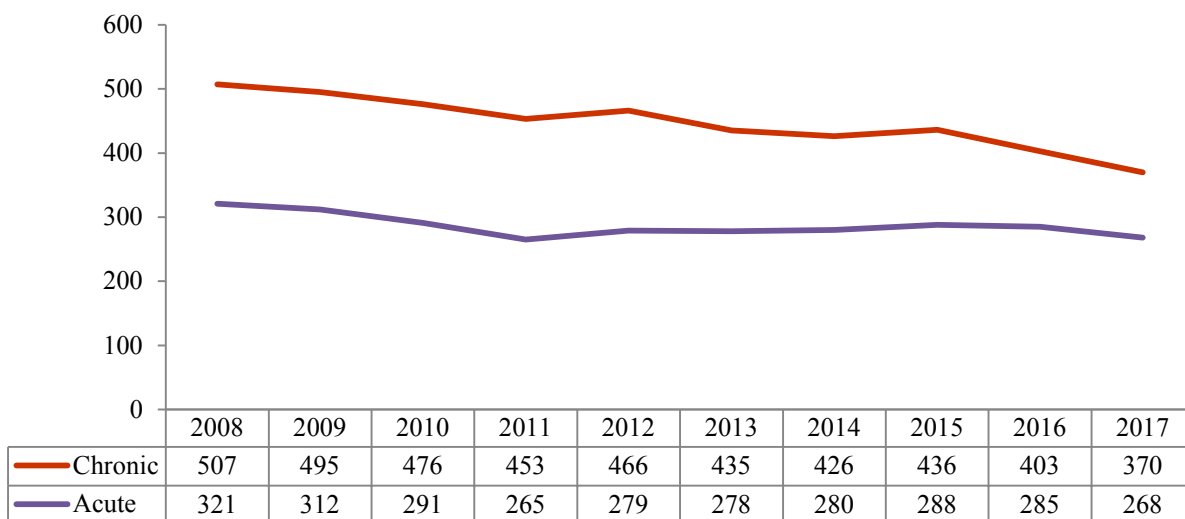


Exhibit 7 reveals that between 2008 and 2017, the average cumulative MMEs per claim during the first 12 months of treatment declined 59 percent for chronic opioid use claims, and 36 percent for acute opioid use claims.

Exhibit 7: Cumulative MMEs per Claim at 12 Months by Year of First Treatment - Chronic vs. Acute Use

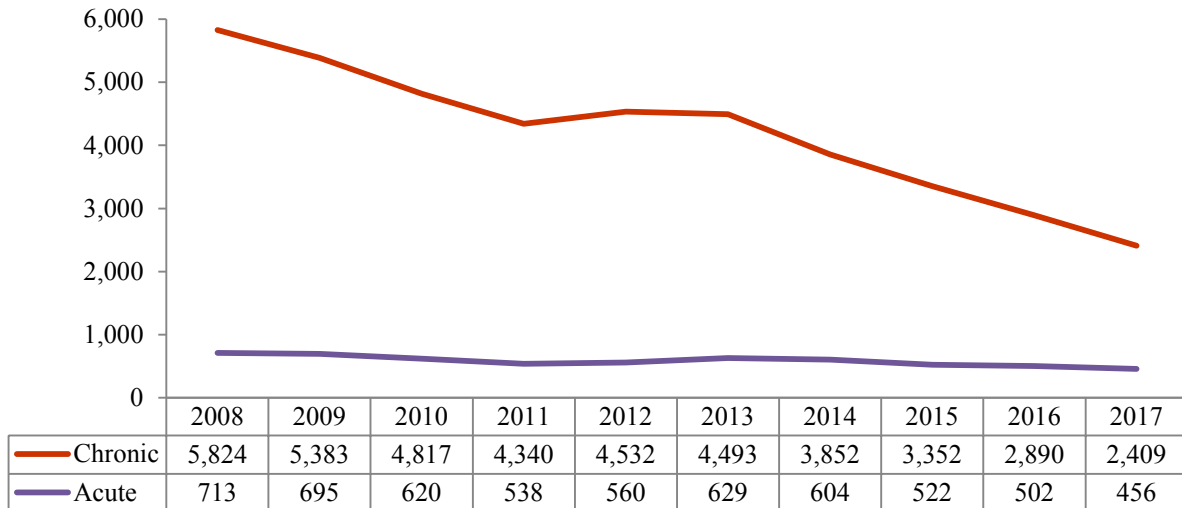
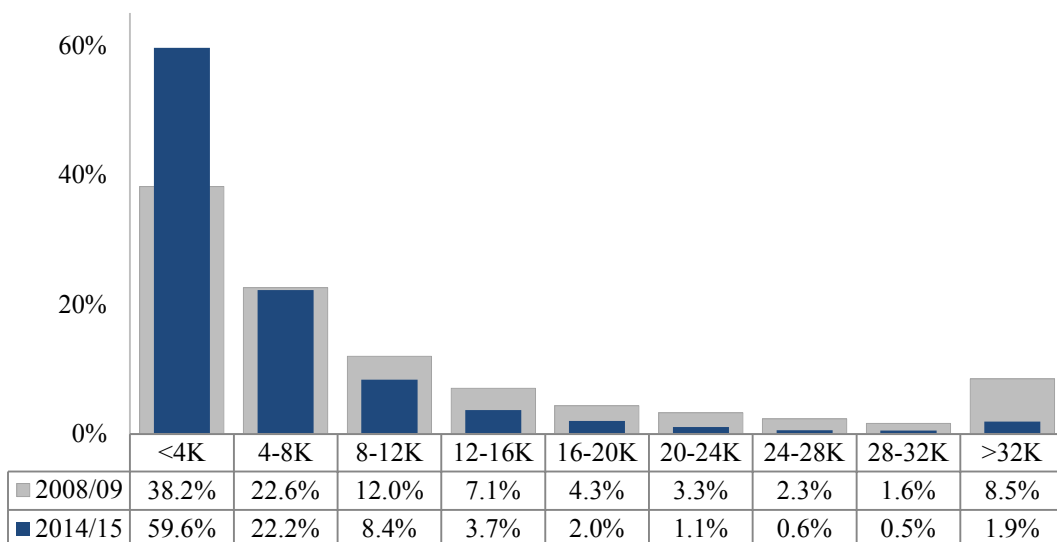


Exhibit 8 shows the impact of the decline in cumulative MMEs within the past decade by comparing the distributions of total MMEs per claim with chronic opioid use for 2008/09 with that for 2014/15 at 36 months of development. The distributions for both periods are skewed to the left, with the largest proportions below 4,000 MMEs and with fewer claims at higher levels of cumulative MMEs. However, between 2008/09 and 2014/15 there was a substantial shift in the distribution of claims from the higher end to the lower end of the range. For example, the proportion of claims in which fewer than 4,000 MMEs had been dispensed increased from 38.2 percent to 59.6 percent while the proportion of claims in which more than 32,000 MMEs were dispensed at 36 months decreased from 8.5 percent to 1.9 percent.

Exhibit 8: Shift in Distribution of Total MMEs per Claim with Chronic Use at 36 Mos - 2008/09 vs. 2014/15



Question 2: To what extent has decreased opioid use driven changes in medical and indemnity cost trends?

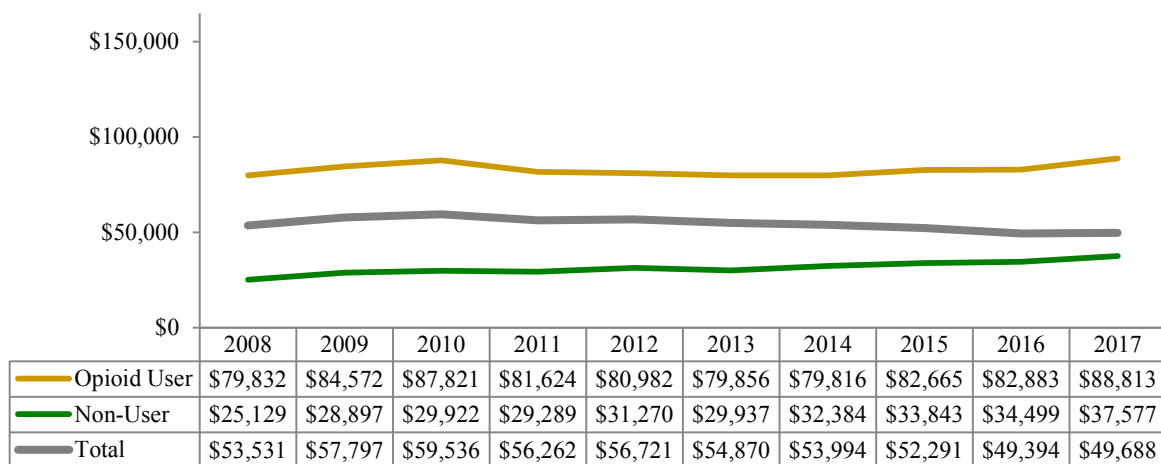
With the shift over time from a greater prevalence of higher cost opioid claims to a greater prevalence of lower cost claims with low or no opioid use (Exhibits 1, 4, 5, 6 and 7), using a single set of historical loss development factors to forecast ultimate claim costs would likely lead to an overstatement of projected costs. Instead, three sets of factors were developed after dividing the historical data into three distinct development groups of chronic opioid use, acute opioid use, and non-opioid use. This is viable because opioid use manifests early in the life of the claim as shown in Exhibit 2.

Exhibits 9 and 10 show the total projected benefit payments¹⁵ per claim at 120 months (10 years) of development for claims with opioid use, claims without opioid use, and both categories combined; and claims with chronic opioid use, claims with acute opioid use, and both categories combined.

Projected benefit payments per claim were derived by multiplying actual payments (valued at 12/31/2018) by loss development factors derived from historical patterns of payment growth from one development period to the next, up to a claim maturity of ten years. The underlying loss development triangles are displayed in Appendix 1 for medical payments and in Appendix 2 for indemnity payments. The loss development factors are shown in Appendix 3. As previously noted, the data presented in this paper were aggregated by the date of first medical treatment. This is different from traditional loss development triangles that aggregate claims data by injury year.

While average benefits (at 10 years of development) for opioid users and non-users are projected to increase, the total for all claims is projected to decline due to the increasing proportion of non-users among lost-time claims. As shown in Exhibit 9, between 2008 and 2017 average benefit payments per claim (at 10 years) decreased by 7 percent (\$53,531 to \$49,688). During the same period, projected benefits on claims with opioid use increased by 11 percent (\$79,832 to \$88,813), and increased by 50 percent (\$25,129 to \$37,577) on claims without opioid use. However, the average benefit payments across all claims decreased due to the decline in higher cost opioid use claims as a proportion of total claims over the 10-year period.

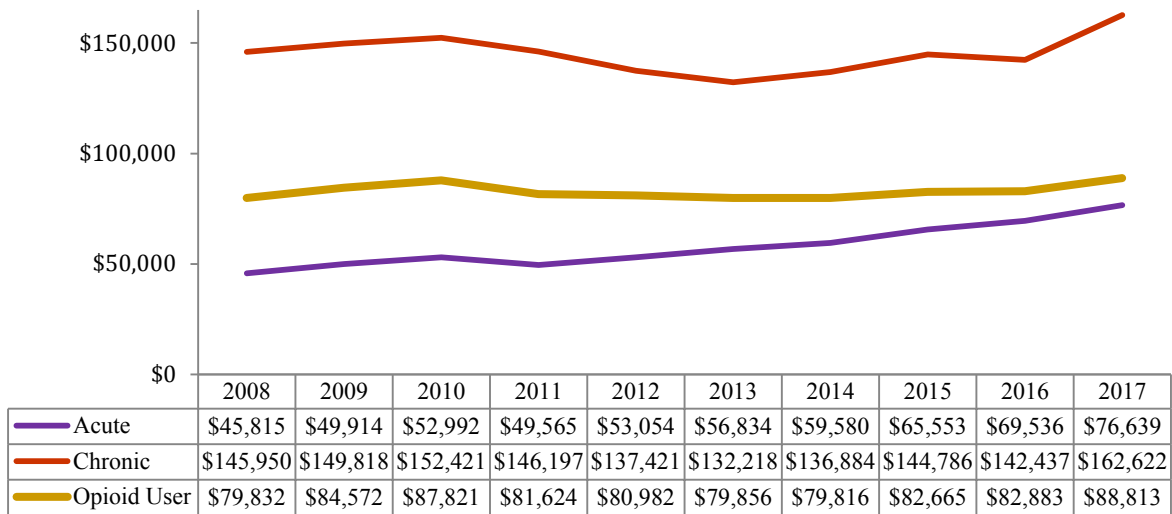
Exhibit 9: Projected 10-Year Average Benefits per Claim - Opioid Use vs. Non-Use by Year of First Treatment



¹⁵ Total benefits include projected medical and indemnity benefit payments for lost-time claims. Indemnity payments include temporary and permanent disability payments.

Exhibit 10 shows the average projected benefit trend lines for all claims with opioid use from 2008 through 2017, also broken out by chronic and acute opioid use claims. Over this 10-year span, average benefit payments on chronic opioid use claims are projected to increase by 11 percent (\$145,950 to \$162,622), and by 67 percent (\$45,815 to \$76,639) on claims with acute opioid use. As discussed above, the combined average benefits for all opioid claims is projected to increase by 11 percent (\$79,832 to \$88,813) due to the shift in the mix of opioid claims, with higher cost chronic users accounting for a smaller share of the claims, and less expensive acute users accounting for a greater share.

Exhibit 10: Projected 10-Year Average Benefits per Claim – Chronic vs. Acute Use by Year of First Treatment

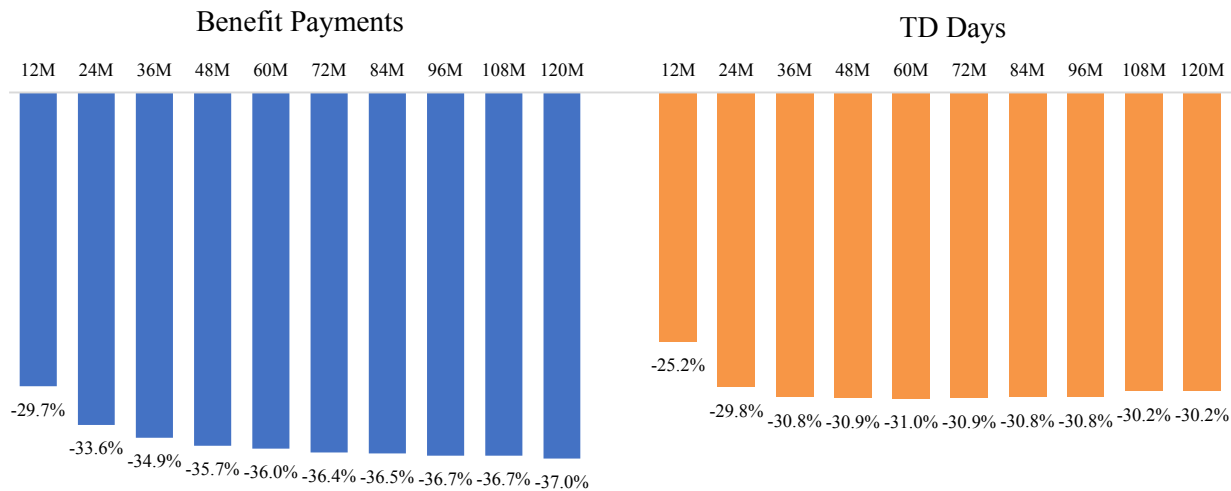


Developing separate projections for opioid acute users, chronic users, and non-users should improve the accuracy of claim forecasts given the significant differences in the populations. However, since chronic opioid use claims now account for a much smaller proportion of opioid claims in workers' compensation, it is possible that claims that remain in this category involve more severe and complex injuries. If so, benefit payments for future chronic opioid claims will likely increase faster than they have in the past, which will need to be considered in future calculations of opioid claims development.

Question 3: What is the impact of declining opioid use on benefit payments, TD days, and systemwide costs?

While claims with opioid use are associated with increased benefit payments and TD days, many other variables also influence claim outcomes. To isolate the effect of opioid use from other variables, the authors used regression analysis to estimate the effect of opioid use versus non-use, as well as chronic use versus acute use, on average benefit payments and TD days.¹⁶ A separate model was developed for each opioid use variable, outcome, and stage of development, which ranged from 12 to 120 months.¹⁷ The change in benefit payments and TD days from avoiding opioid use are summarized in Exhibit 11. Further details are provided in Appendix 5.

Exhibit 11: Change in Benefit Payments and TD Days per Avoided Opioid User



Comparing benefit payments on claims for the same type of injury at 12 months and 120 months (10 years), the results of the regression analysis, displayed in Exhibit 11, reveal that:

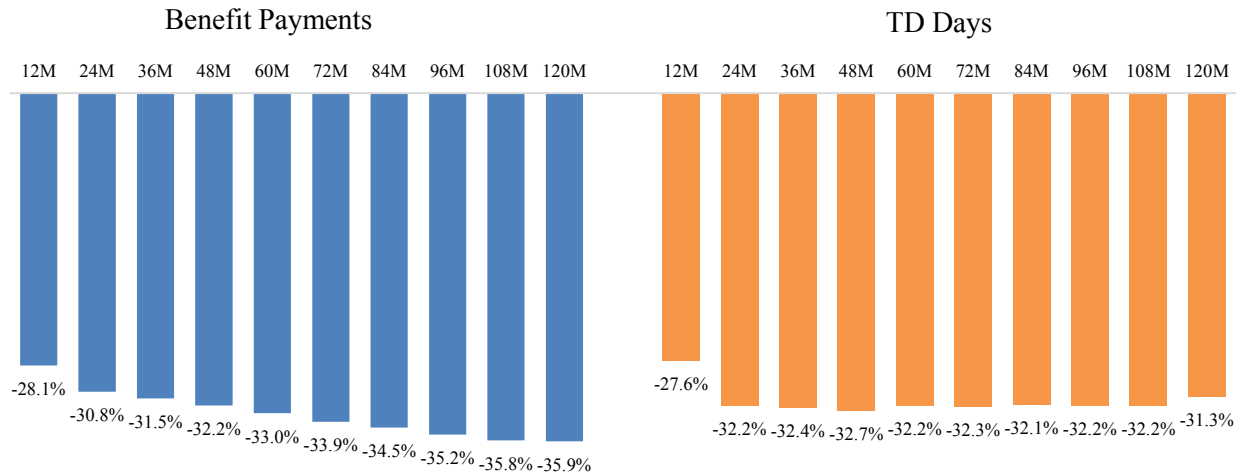
- Average benefit payments on claims without opioid use were 29.7 percent less than on claims with opioids at 12 months, and 37.0 percent less at 120 months.
- Claims without opioid use had 25.2 percent fewer TD days than claims with opioids at 12 months, and 30.2 percent fewer TD days at 120 months.

¹⁶ Regression analysis quantifies the extent and statistical significance of relationships between outcome (dependent) variables and predictor (independent) variables. It isolates the independent effect that each predictor variable has on the outcome variable by controlling for the effects of the other predictor variables.

¹⁷ The regression models were developed using claims with a first treatment date during the baseline period of this study (2008 through 2009), rather than during the entire study period. It seemed reasonable to expect these older claims to be less influenced by changing practice patterns compared to more recent claims. Thus, estimates of the savings per avoided opioid user are not distorted by changing practice patterns.

The regression analysis also revealed differences in benefit payments and TD durations between claims with acute and chronic opioid use.

Exhibit 12: Change in Benefit Payments and TD Days per Avoided Chronic Opioid User



The results of this regression analysis, noted in Exhibit 12, showed:

- Average benefit payments on claims with acute opioid use were 28.1 percent less than on claims with chronic opioid use at 12 months and 35.9 percent less at 120 months.
- Claims with acute opioid use had 27.6 percent fewer TD days than chronic opioid use claims at 12 months, and 31.3 percent fewer TD days at 120 months.

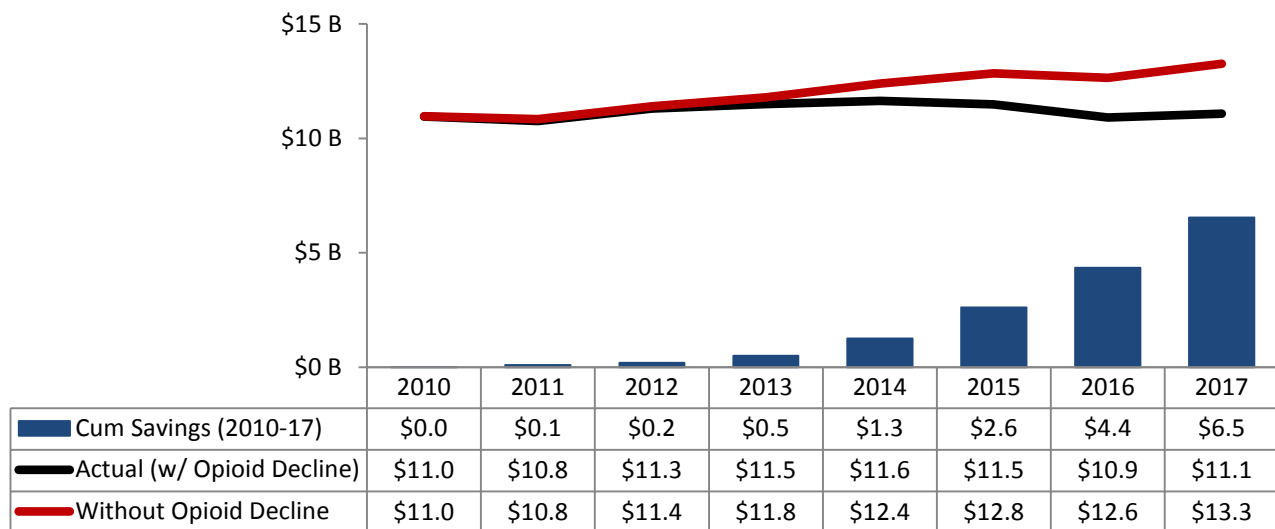
Projected Systemwide Savings

The systemwide savings associated with the declining use of opioids were estimated by distributing the projected savings at 10 years of development over the benefit payments on all California workers' compensation claims. This was done by performing a variance analysis that calculated:

- The total number of *avoided opioid users (and avoided chronic users)*, given the change from baseline in the proportions of claims represented by opioid and non-opioid users; and
- *The average change in benefit payments per avoided opioid user (and chronic user)* from the regression analysis, multiplied by the opioid user (and chronic user) benefit payment per claim.

This estimate of the savings was then used to adjust the projected 10-year benefit payments¹⁸ (with the opioid decline) to reflect what would have been incurred if the opioid use trend had remained at baseline levels. The difference between these two trend lines is the estimated systemwide savings. As shown in Exhibit 13, systemwide savings from the decline in opioid use were projected to reach 16.5 percent (\$11.1 billion in benefit payments with the opioid decline vs. \$13.3 billion in benefits without the opioid decline) for 2017 claims at 10 years of development, while the cumulative (2010-17) savings resulting from declining opioid use were estimated at \$6.5 billion at 10 years of development.

Exhibit 13: Impact of Declining Opioid Use on Projected Benefit Payments: 2010-17 Claims



It should be noted that the savings were not based solely on the change in the mix of opioid user types, given the average cost of each type. Such an approach would have overstated the findings. Instead, regression analysis was used to isolate the effects of opioid use relative to non-use (and chronic use relative to acute use), and thus, to refine the estimated savings. Additional details showing how the total savings amount was derived are provided in Appendix 6 (Tables 6A through 6F).

¹⁸ Projected benefit payments refer to average benefits (paid medical and indemnity) per claim across all lost-time claims (Exhibit 9), multiplied by all lost-time claims, statewide. These claim counts were derived from the *Interactive Policy Year Stats* report - 2019 Edition, compiled by the Workers' Compensation Insurance Rating Bureau (WCIRB).

DISCUSSION

Reforms in the California workers' compensation system addressed excessive opioid use in multiple ways, including codifying the use of evidence-based pain management guidelines with a pharmaceutical formulary that required utilization review for their short- and long-term use.¹⁹ These changes were explicitly designed to address research findings that demonstrated an association between increased opioid use and delayed recovery from injury, delayed return to work, higher medical costs, and friction costs, including higher rates of attorney involvement. Following these reforms, studies have shown significant reductions in opioid use in California workers' compensation, and research that compares data across different states shows that California has seen the largest reductions in the proportion of claims receiving an opioid prescription and in the average number of opioid prescriptions per claim.²⁰

This study addressed three key themes: trends in both the frequency and intensity of chronic and acute opioid use; the relationship between declining opioid utilization and projections of injured worker medical and indemnity benefit payments; and estimates of the impact of the recent declines in opioid use on benefit payments and on the duration of lost time from work.

The results expand on prior findings of a downward trend in opioid use. The proportion of lost-time claims with opioids dispensed in the first 12 months—a time period considered critical to controlling medical treatment and cost—fell by 51 percent between 2008 and 2017. Also, the percentage of claims with chronic opioid use within the first year fell from 13 percent in 2008 to 3 percent in 2017 (a relative decline of 77 percent), while the percentage of claims with acute opioid use fell from 36 percent to 21 percent in the first year of development (a relative decline of 40 percent). Claims in which opioids were dispensed had significantly lower claim closure rates than non-opioid claims across all development periods). For example about two-thirds of non-opioid claims (68 percent) closed within 24 months, but it took twice as long for opioid claims to reach a similar closure rate (69 percent). The projected average cost per claim for all claims with and without opioid use decreased by 7 percent over the 10-year study period, masking the significant 11 and 67 percent increase in cost for injuries with chronic and acute opioid use, respectively. The study estimates a \$6.5 billion savings in the 10-year projected cost of 2010 through 2017 claims from reduced opioid use.

How might the study's principal findings impact the various stakeholders within the workers' compensation system? For injured workers, the use of evidence-based medicine pain management guidelines raises quality of care and facilitates recovery and return to work. For employers, faster injury resolution due to more conservative opioid use reduces their injured workers' time away from the workplace, which increases productivity and potentially lowers workers' compensation premiums due to improved results. Payors stand to benefit from an improved ability to manage opioid utilization and control costs by recalibrating expected cost and reserve projections to reflect lower opioid use and the associated claim outcomes. Legislators and regulators have clear evidence that carefully tailored medical management policy can improve quality of care, improve productivity by promoting faster return-to-work, and lower costs.

Actuaries and underwriters will need access to loss trends that isolate claims with and without opioid use to better predict claim development. It may be that actuaries do not have access to prescription data and cannot segment their own data to differentiate between opioid and non-opioid users. The information in this paper can still be used by actuaries to formulate a rough cost estimate. As demonstrated in

¹⁹ <https://www.dir.ca.gov/dwc/DWCPropRegs/MTUS-Opioids-ChronicPain/Final-Regulations/CleanCopy/Opioids-Guidelines.pdf>; <https://www.dir.ca.gov/dwc/DWCPropRegs/MTUS-Formulary/Final-Regulations/DRUG-LIST.pdf>

²⁰ Thumula, V., Wang, D., Liu, T-C. Interstate Variations in Dispensing Opioids, 5th Edition. WCRI, 2019.

Appendix 4, actuaries can use a frequency-severity approach by using their forecast of lost-time claims by accident year and applying the industry proportion of claims with opioid use to their frequency counts and industry expected costs for each time period to arrive at a cost estimate. A tail factor will need to be applied to take claims to ultimate expected settlement value.

The study's findings raise additional questions. Regarding the precipitous drop in opioid use, how much lower can opioid utilization fall? Future declines will depend on advances in evidence-based medicine research and treatment guidelines, medical providers' continued adoption of alternative pain management protocols, continued elimination of fraudulent and abusive provider practice patterns, increased general awareness of the dangers of opioid use, and the growing number of class action lawsuits filed by state and local officials against opioid manufacturers. Potential declines will also depend on regulatory or legislative changes to the California's Medical Treatment Utilization Schedule, Pharmaceutical Formulary and accompanying medical dispute resolution processes. Recent studies have shown that pharmaceuticals make up 43 percent of all independent medical review and that opioids make up almost one-third of all such drug reviews.²¹ Regulatory or legislative changes that weaken the use of guidelines or revise the dispute resolution process could influence the level of progress made.

It remains to be seen how overall injured worker outcomes will change should the current opioid trend continue to decline. Once the mix of opioid user to non-user (and of chronic user to acute user) stabilizes, will costs for each group change, and at what direction and rate of change? The answers to these questions will be critical to projecting California injured workers' future resource needs.

²¹ David, R., Bullis, R., Jones, S., Young, B. Pre-Reform Medical Service Approval Rates in California Workers' Compensation. CWCI Research Update, October 2019.

Appendix 1: Ten-Year Medical Loss Development Triangles

Table 1.A: Average Paid Medical on Lost-Time Claims – Non-Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$2,499	\$4,019	\$4,926	\$5,570	\$7,771	\$9,580	\$10,710	\$11,529	\$12,174	\$12,552	\$12,789	\$12,982	\$13,092
2009	\$2,640	\$4,477	\$5,485	\$6,235	\$8,868	\$10,802	\$12,195	\$13,255	\$13,989	\$14,487	\$14,778	\$14,959	
2010	\$3,133	\$4,836	\$5,874	\$6,730	\$9,359	\$11,432	\$12,857	\$13,975	\$14,676	\$15,068	\$15,349		
2011	\$2,641	\$4,240	\$5,334	\$6,158	\$9,052	\$11,325	\$12,884	\$13,831	\$14,466	\$14,923			
2012	\$2,341	\$4,095	\$5,146	\$6,160	\$9,522	\$12,004	\$13,557	\$14,591	\$15,274				
2013	\$2,380	\$3,965	\$5,128	\$6,023	\$9,154	\$11,487	\$12,947	\$13,877					
2014	\$2,375	\$3,891	\$5,074	\$6,065	\$9,441	\$12,084	\$13,635						
2015	\$2,479	\$3,982	\$5,124	\$6,114	\$9,731	\$12,105							
2016	\$2,643	\$4,152	\$5,345	\$6,413	\$9,697								
2017	\$2,898	\$4,495	\$5,770	\$6,922									

Table 1.B: Average Paid Medical on Lost-Time Claims – Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$3,931	\$7,083	\$9,442	\$11,602	\$19,537	\$26,798	\$32,444	\$36,685	\$39,886	\$42,450	\$44,270	\$45,558	\$46,466
2009	\$3,863	\$7,607	\$10,331	\$12,699	\$21,872	\$28,980	\$34,964	\$39,452	\$42,515	\$44,925	\$46,616	\$47,870	
2010	\$4,732	\$8,819	\$11,674	\$14,075	\$22,862	\$30,864	\$37,250	\$41,496	\$45,011	\$47,241	\$48,697		
2011	\$4,007	\$7,734	\$10,416	\$12,773	\$22,049	\$29,534	\$35,000	\$39,002	\$41,594	\$43,477			
2012	\$4,318	\$8,046	\$10,969	\$13,477	\$22,919	\$30,225	\$35,326	\$38,798	\$41,072				
2013	\$4,398	\$7,943	\$10,810	\$13,268	\$22,330	\$29,370	\$33,930	\$37,011					
2014	\$4,546	\$7,902	\$10,550	\$12,955	\$21,891	\$28,572	\$33,023						
2015	\$5,513	\$9,037	\$11,775	\$14,236	\$22,875	\$29,025							
2016	\$6,060	\$9,787	\$12,639	\$14,961	\$23,043								
2017	\$7,137	\$10,885	\$13,715	\$16,474									

Table 1.C: Average Paid Medical on Lost-Time Claims - Acute Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$3,640	\$6,024	\$7,699	\$9,119	\$13,897	\$17,654	\$20,248	\$21,832	\$23,015	\$23,826	\$24,331	\$24,734	\$24,990
2009	\$3,617	\$6,524	\$8,397	\$10,079	\$15,464	\$19,146	\$22,048	\$24,141	\$25,482	\$26,373	\$26,875	\$27,304	
2010	\$4,454	\$7,526	\$9,530	\$11,013	\$16,410	\$20,714	\$24,029	\$25,961	\$27,373	\$28,333	\$28,926		
2011	\$3,852	\$6,450	\$8,490	\$10,081	\$15,655	\$19,732	\$22,407	\$24,222	\$25,414	\$26,220			
2012	\$4,104	\$6,641	\$8,938	\$10,715	\$16,769	\$21,045	\$24,134	\$25,938	\$27,179				
2013	\$4,150	\$6,965	\$9,206	\$10,974	\$17,316	\$21,886	\$24,786	\$26,619					
2014	\$4,323	\$7,067	\$8,945	\$10,773	\$17,270	\$22,070	\$25,112						
2015	\$5,259	\$8,083	\$10,304	\$12,186	\$19,031	\$23,693							
2016	\$5,744	\$8,677	\$11,241	\$13,254	\$20,088								
2017	\$6,814	\$9,721	\$12,107	\$14,450									

Table 1.D: Average Paid Medical on Lost-Time Claims - Chronic Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$5,707	\$10,938	\$14,717	\$18,233	\$31,548	\$44,571	\$55,146	\$63,650	\$70,176	\$75,720	\$79,836	\$82,628	\$84,677
2009	\$5,392	\$11,408	\$15,959	\$19,547	\$35,007	\$47,493	\$58,294	\$66,551	\$72,537	\$77,482	\$81,200	\$83,883	
2010	\$6,379	\$13,319	\$17,778	\$21,844	\$35,965	\$49,691	\$60,792	\$68,837	\$75,936	\$80,374	\$83,289		
2011	\$4,998	\$12,437	\$16,346	\$20,060	\$35,719	\$49,278	\$59,852	\$67,946	\$73,156	\$77,134			
2012	\$5,597	\$12,687	\$16,588	\$20,462	\$35,796	\$48,777	\$57,539	\$64,261	\$68,566				
2013	\$6,066	\$11,483	\$15,650	\$19,550	\$34,074	\$46,390	\$54,566	\$60,424					
2014	\$6,329	\$11,427	\$16,421	\$20,264	\$35,352	\$46,906	\$55,083						
2015	\$8,216	\$14,487	\$18,847	\$23,310	\$37,451	\$48,381							
2016	\$10,180	\$17,508	\$20,742	\$23,916	\$36,734								
2017	\$12,577	\$21,190	\$26,299	\$31,083									

Table 1.E: Average Paid Medical on Lost-Time Claims - Opioid Users and Non-Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$3,122	\$5,441	\$7,102	\$8,542	\$13,802	\$18,520	\$22,046	\$24,668	\$26,640	\$28,171	\$29,238	\$30,003	\$30,529
2009	\$3,176	\$5,941	\$7,833	\$9,449	\$15,577	\$20,238	\$24,040	\$26,880	\$28,823	\$30,312	\$31,322	\$32,051	
2010	\$3,819	\$6,670	\$8,648	\$10,332	\$16,234	\$21,371	\$25,333	\$28,079	\$30,218	\$31,541	\$32,419		
2011	\$3,256	\$5,919	\$7,850	\$9,484	\$15,725	\$20,710	\$24,275	\$26,795	\$28,439	\$29,621			
2012	\$3,237	\$5,986	\$8,002	\$9,819	\$16,361	\$21,333	\$24,687	\$26,944	\$28,420				
2013	\$3,235	\$5,805	\$7,849	\$9,557	\$15,726	\$20,419	\$23,421	\$25,411					
2014	\$3,243	\$5,636	\$7,534	\$9,186	\$15,124	\$19,596	\$22,452						
2015	\$3,436	\$5,746	\$7,550	\$9,133	\$14,703	\$18,498							
2016	\$3,474	\$5,720	\$7,497	\$8,997	\$13,818								
2017	\$3,695	\$5,882	\$7,590	\$9,169									

Appendix 2: Ten-Year Indemnity Loss Development Triangles

Table 2.A: Average Paid Indemnity on Lost-Time Claims - Non-Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$2,439	\$3,476	\$4,325	\$5,026	\$7,444	\$9,171	\$10,235	\$10,862	\$11,289	\$11,602	\$11,776	\$11,934	\$12,037
2009	\$2,485	\$3,621	\$4,496	\$5,276	\$8,408	\$10,328	\$11,578	\$12,444	\$12,897	\$13,272	\$13,532	\$13,693	
2010	\$2,833	\$4,104	\$5,093	\$6,004	\$8,952	\$10,824	\$12,038	\$12,804	\$13,372	\$13,682	\$13,933		
2011	\$2,478	\$3,764	\$4,639	\$5,445	\$8,368	\$10,324	\$11,649	\$12,350	\$12,792	\$13,200			
2012	\$2,609	\$3,876	\$4,969	\$5,995	\$9,609	\$11,478	\$12,719	\$13,441	\$13,923				
2013	\$2,536	\$3,846	\$4,903	\$5,873	\$9,003	\$10,944	\$12,126	\$12,968					
2014	\$2,503	\$3,796	\$4,939	\$5,961	\$9,700	\$12,168	\$13,544						
2015	\$2,706	\$4,257	\$5,548	\$6,636	\$10,936	\$13,297							
2016	\$2,777	\$4,343	\$5,593	\$6,927	\$11,060								
2017	\$2,892	\$4,573	\$5,996	\$7,308									

Table 2.B: Average Paid Indemnity on Lost-Time Claims - Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$3,028	\$5,189	\$7,162	\$9,102	\$16,416	\$22,224	\$26,329	\$29,083	\$31,220	\$32,828	\$33,920	\$34,738	\$35,378
2009	\$2,986	\$5,197	\$7,211	\$9,325	\$18,076	\$23,898	\$27,932	\$30,892	\$32,960	\$34,391	\$35,707	\$36,750	
2010	\$3,441	\$5,975	\$8,278	\$10,537	\$18,880	\$24,636	\$29,103	\$31,908	\$33,961	\$35,355	\$36,422		
2011	\$3,150	\$5,518	\$7,677	\$9,831	\$17,956	\$23,628	\$27,429	\$30,061	\$31,877	\$33,211			
2012	\$3,240	\$5,618	\$7,888	\$10,122	\$18,506	\$24,004	\$27,915	\$30,287	\$31,908				
2013	\$3,363	\$6,104	\$8,580	\$11,073	\$19,960	\$25,903	\$29,419	\$31,631					
2014	\$3,425	\$6,085	\$8,617	\$11,143	\$20,742	\$26,988	\$30,870						
2015	\$3,756	\$6,749	\$9,585	\$12,246	\$22,776	\$29,197							
2016	\$4,148	\$7,328	\$10,260	\$13,086	\$23,164								
2017	\$4,249	\$7,666	\$10,804	\$13,837									

Table 2.C: Average Paid Indemnity on Lost-Time Claims - Acute Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$2,862	\$4,516	\$5,965	\$7,298	\$11,860	\$15,344	\$17,504	\$18,640	\$19,534	\$20,081	\$20,442	\$20,658	\$20,825
2009	\$2,795	\$4,499	\$5,978	\$7,457	\$12,986	\$16,506	\$18,720	\$20,098	\$20,910	\$21,393	\$21,802	\$22,148	
2010	\$3,249	\$5,240	\$6,933	\$8,486	\$13,918	\$17,071	\$19,604	\$20,869	\$21,737	\$22,325	\$22,803		
2011	\$2,970	\$4,845	\$6,480	\$8,041	\$13,069	\$16,369	\$18,300	\$19,750	\$20,590	\$21,212			
2012	\$3,057	\$4,891	\$6,564	\$8,197	\$13,721	\$17,341	\$19,832	\$21,189	\$22,052				
2013	\$3,234	\$5,512	\$7,536	\$9,494	\$16,032	\$20,136	\$22,509	\$23,847					
2014	\$3,301	\$5,587	\$7,692	\$9,703	\$17,056	\$21,652	\$24,382						
2015	\$3,655	\$6,275	\$8,708	\$11,016	\$19,600	\$24,581							
2016	\$4,057	\$6,929	\$9,470	\$11,960	\$20,494								
2017	\$4,159	\$7,295	\$10,144	\$12,878									

Table 2.D: Average Paid Indemnity on Lost-Time Claims - Chronic Opioid Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$4,042	\$7,636	\$10,784	\$13,917	\$26,116	\$35,596	\$42,756	\$48,041	\$52,200	\$55,599	\$57,962	\$59,801	\$61,273
2009	\$4,181	\$7,648	\$10,799	\$14,206	\$28,510	\$37,815	\$44,572	\$49,996	\$54,201	\$57,201	\$60,067	\$62,321	
2010	\$4,578	\$8,535	\$12,106	\$15,741	\$28,958	\$38,669	\$46,016	\$51,338	\$55,392	\$58,187	\$60,251		
2011	\$4,300	\$7,982	\$11,358	\$14,675	\$28,404	\$38,249	\$45,443	\$50,252	\$53,895	\$56,615			
2012	\$4,336	\$8,019	\$11,549	\$14,992	\$28,526	\$37,468	\$43,957	\$48,300	\$51,413				
2013	\$4,233	\$8,246	\$11,732	\$15,396	\$29,163	\$39,021	\$45,011	\$49,169					
2014	\$4,416	\$8,190	\$11,998	\$15,968	\$31,479	\$42,036	\$48,965						
2015	\$4,833	\$9,453	\$13,798	\$17,691	\$34,820	\$45,953							
2016	\$5,326	\$10,100	\$14,835	\$18,996	\$35,529								
2017	\$5,778	\$10,952	\$15,967	\$20,761									

Table 2.E: Average Paid Indemnity on Lost-Time Claims - Opioid Users and Non-Users

Year	Month 3	Month 6	Month 9	Month 12	Month 24	Month 36	Month 48	Month 60	Month 72	Month 84	Month 96	Month 108	Month 120
2008	\$2,695	\$4,271	\$5,692	\$7,035	\$12,043	\$15,948	\$18,629	\$20,379	\$21,693	\$22,690	\$23,347	\$23,849	\$24,232
2009	\$2,705	\$4,358	\$5,811	\$7,289	\$13,397	\$17,372	\$20,085	\$22,039	\$23,330	\$24,252	\$25,055	\$25,668	
2010	\$3,093	\$4,966	\$6,616	\$8,227	\$14,007	\$17,889	\$20,766	\$22,595	\$23,921	\$24,779	\$25,444		
2011	\$2,780	\$4,607	\$6,143	\$7,651	\$13,291	\$17,180	\$19,777	\$21,472	\$22,622	\$23,501			
2012	\$2,895	\$4,709	\$6,401	\$8,059	\$14,151	\$17,891	\$20,488	\$22,037	\$23,087				
2013	\$2,887	\$4,890	\$6,664	\$8,410	\$14,469	\$18,416	\$20,757	\$22,273					
2014	\$2,872	\$4,792	\$6,591	\$8,308	\$14,740	\$18,920	\$21,424						
2015	\$3,037	\$5,127	\$7,021	\$8,721	\$15,415	\$19,305							
2016	\$3,111	\$5,173	\$6,970	\$8,789	\$14,798								
2017	\$3,147	\$5,245	\$7,097	\$8,844									

Appendix 3: Ten-Year Loss Development Factors

Table 3.A: Ten-Year Loss Development Factors by Opioid User Type – Paid Medical Benefits

Year	Non-User	User	Acute	Chronic	Total
2008	1.000	1.000	1.000	1.000	1.000
2009	1.008	1.020	1.010	1.025	1.018
2010	1.022	1.048	1.027	1.057	1.043
2011	1.042	1.084	1.047	1.086	1.075
2012	1.072	1.136	1.082	1.137	1.120
2013	1.122	1.207	1.135	1.193	1.185
2014	1.205	1.321	1.219	1.305	1.290
2015	1.359	1.526	1.384	1.529	1.479
2016	1.715	1.964	1.746	1.924	1.888
2017	2.662	3.091	2.686	2.774	2.970

Table 3.B: Ten-Year Loss Development Factors by Opioid User Type - Paid Indemnity Benefits

Year	Non-User	User	Acute	Chronic	Total
2008	1.000	1.000	1.000	1.000	1.000
2009	1.009	1.018	1.008	1.025	1.016
2010	1.021	1.046	1.021	1.069	1.039
2011	1.041	1.081	1.042	1.103	1.071
2012	1.069	1.126	1.072	1.156	1.111
2013	1.108	1.190	1.117	1.222	1.167
2014	1.178	1.286	1.188	1.327	1.253
2015	1.308	1.465	1.333	1.541	1.416
2016	1.615	1.893	1.682	2.019	1.796
2017	2.621	3.435	2.937	3.680	3.098

Appendix 4: Example Calculations

Table 4.A: Calculation of 10-Year Benefit Cost for 1,000 Claims Based on Industry Mix of Opioid Utilization

	Industry Frequency (30%/70%)	Industry Severity			Industry Estimated 10-Year Cost
		Paid for 2016 ¹	Loss Dev. Factor ²	10-Year Cost Severity	
	A	B	C	D = B x C	E = A x D
Claims w/ Opioids					
Medical	300	23,043	1.964	\$45,266	\$13,579,905
Indemnity	300	23,164	1.893	\$43,840	\$13,151,853
Subtotal					\$26,731,758
Claims w/o Opioids					
Medical	700	9,697	1.715	\$16,633	\$11,642,872
Indemnity	700	11,060	1.615	\$17,866	\$12,506,265
Subtotal					\$24,149,137
Total	1,000				\$50,880,895

¹Appendix 1 & 2: Ten-year paid on lost-time claims for non-opioid users and users: Tables 1.A and 1.B for paid medical and Tables 2.A and 2.B for paid indemnity.

²Appendix 3: Ten-year loss development factors for paid medical (Table 3.A) and paid indemnity (Table 3.B).

Table 4.B: Sensitivity Analysis

	Illustrative Range of Frequency			Illustrative Range of Estimated 10-Year Cost		
	Industry Avg ¹ (30%/70%)	Low Estimate ² (24%/76%)	High Estimate ³ (37%/63%)	Industry Average	Low Estimate	High Estimate
	A	B	C	D=A x 10-Yr Severity	E=B x 10-Yr Severity	F=C x 10-Yr Severity
Claims w/ Opioids						
Medical	300	240	370	\$13,579,905	\$10,863,924	\$16,748,549
Indemnity	300	240	370	\$13,151,853	\$10,521,482	\$16,220,619
Subtotal				\$26,731,758	\$21,385,406	\$32,969,168
Claims w/o Opioids						
Medical	700	760	630	\$11,642,872	\$12,640,832	\$10,478,584
Indemnity	700	760	630	\$12,506,265	\$13,578,231	\$11,255,639
Subtotal				\$24,149,137	\$26,219,063	\$21,734,223
Total	1,000	1,000	1,000	\$50,880,895	\$47,604,469	\$54,703,391

¹ Point Estimate: 2016 claims; assuming Industry mix of claims with and without opioid use (Exhibit 1; 2016 proportions).

² Low Estimate: 2016 claims; company is faster by one year (Exhibit 1; 2017 proportions) to reduce opioids than industry.

³ High Estimate: 2016 claims; company is slower by one year (Exhibit 1; 2015 proportions) to reduce opioids than industry.

Appendix 5: Regression Coefficients

Table 5.A shows the change in expected benefits paid per avoided opioid user, and how it was derived from the regression coefficient of the opioid use variable. For example, at 12 months, the regression coefficient for average benefits paid is 0.353. When running the model, the dependent variable was transformed using a log function, a common practice when modeling skewed data. The coefficient was then transformed back to its original scale using the exponential function, thereby reversing the log transformation function. The resulting value, 1.423, indicates that for every \$1.00 paid on a non-user claim, \$1.423 was paid on an opioid user claim. Put another way, payments on a claim with opioid use are expected to exceed payments on a similar claim without opioid use by 42.3 percent at 12 months of development.

When opioid use is avoided, the relevant comparison is the ratio of non-user cost to opioid user cost, i.e., $1 / 1.423$ (the reciprocal of the log transformed regression coefficient), which equals 0.703 at 12 months. This represents a savings of 29.7 percent ($1 - 0.703 \times 100$) for each avoided claim with opioids.

Table 5.A: Effect of Opioid Use vs. Non-Use on Average Benefits Paid (Estimated using 2008/2009 claims)

Claim Age	Regression Coefficient	Ratio of User Cost to Non-User Cost	Ratio of Non-User Cost to User Cost	Change Per Avoided Opioid User
	A	$B=e^A$	$C=1/B$	$D=C-1 \times 100$
12 Months	0.353	1.423	0.703	-29.7%
24 Months	0.410	1.507	0.664	-33.6%
36 Months	0.430	1.537	0.651	-34.9%
48 Months	0.441	1.554	0.643	-35.7%
60 Months	0.446	1.562	0.640	-36.0%
72 Months	0.452	1.571	0.636	-36.4%
84 Months	0.454	1.575	0.635	-36.5%
96 Months	0.457	1.580	0.633	-36.7%
108 Months	0.457	1.580	0.633	-36.7%
120 Months ¹	0.462	1.587	0.630	-37.0%

¹ The regression coefficient at 120 months was estimated using 2008 claims, because the payments for 2009 claims were not available beyond 108 months.

Table 5.B. shows the percentage change in average TD days paid per avoided opioid user at level of claim development, and how it was derived from the regression coefficient of the opioid use variable. Table 5.C. shows the effect of chronic vs. acute opioid use on average benefit payments at the various levels of development and provides the regression coefficients and ratios used to calculate the change per avoided opioid user. Table 5.D. shows the percentage change in average TD days paid on chronic vs. acute opioid use claims and also provides the details on how those figures were derived.

Table 5.B: Effect of Opioid Use vs Non-Use on Average TD Days (Estimated using 2008/2009 claims)

Claim Age	Regression Coefficient	Ratio of User Days to Non-User Days	Ratio of Non-User Cost to User Days	Change Per Avoided Opioid User
	A	$B=e^A$	$C=1/B$	$D=C-1 \times 100$
12 Months	0.290	1.336	0.748	-25.2%
24 Months	0.353	1.424	0.702	-29.8%
36 Months	0.368	1.445	0.692	-30.8%
48 Months	0.370	1.448	0.691	-30.9%
60 Months	0.371	1.448	0.690	-31.0%
72 Months	0.370	1.447	0.691	-30.9%
84 Months	0.369	1.446	0.692	-30.8%
96 Months	0.368	1.445	0.692	-30.8%
108 Months	0.360	1.433	0.698	-30.2%
120 Months ¹	0.359	1.432	0.698	-30.2%

¹The regression coefficient at 120 months was estimated using 2008 claims, because the payments for 2009 claims were not available beyond 108 months.

Table 5.C: Effect of Chronic vs Acute Opioid Use on Average Benefit Payments (Estimated using 2008/2009 claims)

Claim Age	Regression Coefficient	Ratio of Chronic User Cost to Acute User Cost	Ratio of Acute User Cost to Chronic User Cost	Change Per Avoided Chronic Opioid User
	A	$B=e^A$	$C=1/B$	$D=C-1 \times 100$
12 Months	0.330	1.391	0.719	-28.1%
24 Months	0.368	1.445	0.692	-30.8%
36 Months	0.379	1.460	0.685	-31.5%
48 Months	0.388	1.475	0.678	-32.2%
60 Months	0.401	1.494	0.670	-33.0%
72 Months	0.414	1.513	0.661	-33.9%
84 Months	0.424	1.527	0.655	-34.5%
96 Months	0.434	1.543	0.648	-35.2%
108 Months	0.444	1.559	0.642	-35.8%
120 Months ¹	0.445	1.560	0.641	-35.9%

¹The regression coefficient at 120 months was estimated using 2008 claims, because the payments for 2009 claims were not available beyond 108 months.

Table 5.D: Effect of Chronic vs Acute Opioid Use on Average TD Days (Estimated using 2008/2009 claims)

Claim Age	Regression Coefficient	Ratio of Chronic User Days to Acute User Days	Ratio of Acute User Days to Chronic User Days	Change Per Avoided Chronic Opioid User
	A	$B=e^A$	$C=1/B$	$D=C-1 \times 100$
12 Months	0.323	1.381	0.724	-27.6%
24 Months	0.388	1.474	0.678	-32.2%
36 Months	0.391	1.479	0.676	-32.4%
48 Months	0.395	1.485	0.673	-32.7%
60 Months	0.389	1.475	0.678	-32.2%
72 Months	0.390	1.476	0.677	-32.3%
84 Months	0.388	1.474	0.679	-32.1%
96 Months	0.388	1.474	0.678	-32.2%
108 Months	0.389	1.476	0.678	-32.2%
120 Months ¹	0.376	1.456	0.687	-31.3%

¹ The regression coefficient at 120 months was estimated using 2008 claims, because the payments for 2009 claims were not available beyond 108 months.

Appendix 6: Estimated Systemwide Savings (2010-2017) at Ten Years of Development

Tables 6.A through 6.F show how the total savings from lower opioid use and lower chronic use relative to acute use were calculated. The first step was to establish a 2008/09 baseline of total benefit payments. This was defined as total lost-time claims by year (2010-2017), multiplied by average benefits paid per claim (2010-2017), and weighted by the baseline proportions (2008/09) of claims in each opioid use category. Calculation of the variance from this baseline is described below. This variance from baseline was expressed as a percentage (i.e., variance divided by baseline) for each year (2010-2017), and these percentages were used to adjust the actual benefits trend displayed in Exhibit 9 (average paid) and Appendix Table 6.C (total dollars paid).

In 2017, for example, 63,034 opioid users were avoided (Table 6.D). This figure was derived from total lost-time claims, 222,928 (Table 6.C), multiplied by the 28.3 percentage point change from baseline in the proportion of all opioid users, 23.6 percent minus 51.9 percent (Table 6.B). These 63,034 claims were then multiplied by the average benefit payment change, which was derived from the change per avoided opioid user (-37.0 percent), multiplied by the all opioid users' average benefits, \$88,813 (Table 6.A). Thus, the savings produced by avoiding opioids on these claims is estimated at \$2.071 billion (Table 6.D).

Similarly, 10,629 claims with chronic opioid use were avoided in 2017, with an estimated savings of \$0.619 billion (Table 6.E) – i.e., avoided chronic users (10,629), multiplied by the savings associated with chronic use relative to acute use of opioids (-35.9 percent), multiplied by the chronic user average benefits per claim (\$162,662).

Table 6.A: 10-Year Projected Benefits per Claim (Paid + Incurred)

Year	Non-User	All Opioid Users	Acute	Chronic	Total
2008/09	\$26,997	\$82,182	\$47,835	\$147,888	\$55,646
2010	\$29,922	\$87,821	\$52,992	\$152,421	\$59,536
2011	\$29,289	\$81,624	\$49,565	\$146,197	\$56,262
2012	\$31,270	\$80,982	\$53,054	\$137,421	\$56,721
2013	\$29,937	\$79,856	\$56,834	\$132,218	\$54,870
2014	\$32,384	\$79,816	\$59,580	\$136,884	\$53,994
2015	\$33,843	\$82,665	\$65,553	\$144,786	\$52,291
2016	\$34,499	\$82,883	\$69,536	\$142,437	\$49,394
2017	\$37,577	\$88,813	\$76,639	\$162,622	\$49,688

Table 6.B: Projected Opioid Use Rate at 36 Months Development

Year	Non-User	All Opioid Users	Acute	Chronic	Chronic / All Opioid Users
2008/09	48.1%	51.9%	34.1%	17.8%	34.3%
2010	48.9%	51.1%	33.2%	17.9%	35.0%
2011	48.5%	51.5%	34.4%	17.1%	33.2%
2012	48.8%	51.2%	34.2%	16.9%	33.1%
2013	50.1%	49.9%	34.7%	15.3%	30.5%
2014	54.4%	45.6%	33.6%	11.9%	26.2%
2015	62.2%	37.8%	29.6%	8.2%	21.6%
2016	69.2%	30.8%	25.1%	5.6%	18.3%
2017	76.4%	23.6%	20.3%	3.3%	14.2%

Table 6.C: 10-Year Projected Claim Frequency and Baseline Benefits

Year	Lost-Time Claim Frequency ¹	Baseline Benefits ²
	A	B=A x Avg Baseline Benefits
2008/09	177,723	\$9,889,551,898
2010	184,164	\$10,979,489,368
2011	191,318	\$10,912,102,928
2012	199,345	\$11,485,119,583
2013	209,518	\$12,012,676,879
2014	215,594	\$12,995,806,294
2015	219,586	\$14,146,916,501
2016	221,000	\$14,515,308,706
2017	222,928	\$16,313,611,683
2010-17		\$103,361,031,943

¹ Workers' Compensation Insurance Rating Bureau (WCIRB), *Interactive Policy Year Stats* report - 2019 Edition.

² Average benefits (Table 6.A) weighted by the baseline mix of opioid use rates (Table 6.B), and multiplied by claim frequency.

Table 6.D: Change in Benefits Due to Shift from Opioid Use to Non-Use

Year	Opioid Use Rate Change from Baseline	Avoided Opioid Users	Avoided Benefits ¹	Change from Baseline
	A=Rate-Baseline Rate	B = Claims x A	C = B x User Benefits x 0.370	D = C / Baseline
2010	-0.8%	-1,413	-\$45,911,100	-0.4%
2011	-0.4%	-717	-\$21,666,994	-0.2%
2012	-0.7%	-1,430	-\$42,850,951	-0.4%
2013	-2.0%	-4,121	-\$121,773,404	-1.0%
2014	-6.4%	-13,699	-\$404,574,178	-3.1%
2015	-14.1%	-31,022	-\$948,874,729	-6.7%
2016	-21.1%	-46,696	-\$1,432,066,364	-9.9%
2017	-28.3%	-63,034	-\$2,071,397,740	-12.7%
2010-17			-\$5,089,115,459	-4.9%

¹ Average benefits paid per opioid user is multiplied by the change per avoided opioid user, 37.0% at 120 months, shown in appendix table 6.A.

Table 6.E: Change in Benefits Due to Shift from Chronic to Acute Use

Year	Chronic Use Rate Change from Baseline ¹	Opioid Use Rate	Avoided Chronic Users	Avoided Benefits ²	Change from Baseline
	A=Rate-Baseline Rate	B	B = Claims x A x B	C = B x Chronic Benefits x 0.359	D = C / Baseline
2010	0.7%	51.1%	660	\$36,054,898	0.3%
2011	-1.2%	51.5%	-1,137	-\$59,556,375	-0.5%
2012	-1.2%	51.2%	-1,251	-\$61,590,764	-0.5%
2013	-3.8%	49.9%	-3,964	-\$187,860,353	-1.6%
2014	-8.2%	45.6%	-8,007	-\$392,794,885	-3.0%
2015	-12.7%	37.8%	-10,564	-\$548,165,952	-3.9%
2016	-16.0%	30.8%	-10,899	-\$556,400,430	-3.8%
2017	-20.2%	23.6%	-10,629	-\$619,486,991	-3.8%
2010-17				-\$2,389,800,852	-2.3%

¹ The chronic use rate represents chronic opioid users as a proportion of all acute plus chronic opioid users (not all lost-time claims).

² Average benefits paid per chronic opioid user is multiplied by the change per avoided chronic user, 35.9% at 120 months (Table 6.C).

Table 6.F: 10-Year Projected Benefits - With and Without Estimated Opioid Decline

Year	Actual Benefits w/ Opioid Decline¹	Total Change from Baseline²	Benefits Without Opioid Decline³	Total Savings
	A = Claims x Avg Benefits	B	C = A / (B+1)	D = C - A
2010	\$10,964,294,710	-0.1%	\$10,974,146,115	\$9,851,405
2011	\$10,763,920,952	-0.7%	\$10,844,642,182	\$80,721,230
2012	\$11,307,043,657	-0.9%	\$11,410,809,623	\$103,765,966
2013	\$11,496,321,894	-2.6%	\$11,800,486,315	\$304,164,421
2014	\$11,640,754,887	-6.1%	\$12,401,670,211	\$760,915,323
2015	\$11,482,401,235	-10.6%	\$12,841,277,955	\$1,358,876,720
2016	\$10,915,988,364	-13.7%	\$12,648,753,937	\$1,732,765,572
2017	\$11,076,906,676	-16.5%	\$13,264,917,868	\$2,188,011,192
2010-17	\$89,647,632,375	-7.2%	\$96,186,704,205	\$6,539,071,830

¹ Average Benefits per claim (Table 6.A) multiplied by Claim Frequency (Table 6.C).

² Combined change from baseline due to lower opioid use (Table 6.C) and from lower chronic use (Table 6.E).

³ This grosses up actual benefits by the percentage change from baseline.

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